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Scientific, Technical and Economic Committee for Fisheries (STECF)

Assessment of Mediterranean Sea stocks - part 1 (STECF-14-17)

Edited by Massimiliano CARDINALE and Dimitrios DAMALAS

This report was reviewed by the STECF during its 2014 winter plenary meeting

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Assessment of Mediterranean Sea stocks - part 1 (STECF-14-17)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS, BELGIUM BETWEEN 10-14 NOVEMBER 2014

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting, evaluate the findings and make any appropriate comments and recommendations.

Introduction

The report of the Expert Working Group on Assessment of Mediterranean Sea stocks – part 1 (STECF EWG 14-19) was reviewed by the STECF during the plenary meeting held from 10 to 14 November 2014 in Brussels, Belgium. The following observation and conclusions represent the outcome of that review.

Observations of the STECF

The meeting was the first STECF expert meeting for undertaking stock assessments of small pelagic and demersal species in the Mediterranean planned for 2014. The meeting was held in Rome, Italy from 14 to 18 July 2014. The meeting chair person was Massimiliano Cardinale and the EWG was attended by 21 experts in total, including 4 STECF members plus 3 JRC experts.

Historic fisheries and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 15th 2014 with deadlines on 9th of June 2014. All concerned member states provided the requested data, although not always in respect of the deadline.

In relation to each of the Terms of Reference (ToRs), STECF notes the following:

ToRs (a-b) Update and assess historic and recent stock parameters: the EWG 14-09 undertook the stock assessment of 15 stocks. 13 out of these 15 assessed stocks were classified as exploited unsustainably; the status of the remaining 2 stocks could not be defined (Table 5.1.1.).

ToR (c) Provide for each of the 15 priority stocks a short term and a medium term forecast: the EWG 14-09 conducted short term forecasts of stock size and catches for 11 stocks and medium term forecast for two stocks (Table 5.1.1.).

ToR (d) Evaluation of DCF data quality by EWG experts: in fulfilment of TOR (d), stock specific evaluation of the data quality were conducted for all stocks requested under ToR (a-c) by the EWG 14-09 experts. Moreover, JRC team examined the data coverage and quality for the fisheries and survey data. This was performed by means of data exploration and the MEDITS SQL quality checks developed by JRC. Results of the evaluations are reported under chapter 5 - ToR (d) and at the end of the assessment section of each stock. Data coverage was not always complete in the latest data call: France did not provide any fisheries data for GSA 8 (Corsica); moreover effort data for all French GSA's are absent prior to 2012. Italy in general did not provide any fisheries data prior to 2005. Apparently, lack of specific Croatian data for 2012 and 2013 did not allow the EWG to apply an analytical methodology for assessing hake in GSA 17. Additionally, officially submitted sardine landings data from Croatia was not used during EWG 14-09; experts identified them as incorrect and used their own 'correct' data. As a result of not undertaking data collection in accordance with DCF requirements, Greece did not submit any data for 2009-2012 and submitted only last quarter of 2013. Due to this gap in data, stock assessment (except small pelagics) seems unlikely to be performed for any demersal species in the next 2-3 years. More detailed issues identified in the data are described in the stock assessment sections of the EWG 14-09 report. In addition TOR (d) section includes a more extended data coverage/quality evaluation, reporting on all data collected under the 2014 Data Call and not only those related to the stocks assessed.

Conclusions of the STECF

Based on the findings in the EWG 14-09 report, STECF concludes the following:

Among the 15 demersal and small pelagic stocks assessed by the EWG 14-09, 13 are currently being exploited at rates not consistent with achieving MSY (overfishing is occurring) and 2 stocks were not assessed due to data deficiencies or poor model fits. A summary of stock status is given in Table 1.

Table 1. Summary of stock status for the 15 stocks assessed by the EWG 14-09.

Stock area	Species	Common name	Assessment	F	F_{MSY}	F/F_{MSY}	B/B_{lim}	Short term	Medium term
GSA 6	*Merluccius merluccius*	Hake	XSA	1.48	0.15	9.87		Yes	No
GSA 6	*Mullus barbatus*	Red mullet	XSA	1.47	0.45	3.27		Yes	No
GSA 6	*Micromesistius poutassou*	Blue whiting	XSA	1.52	0.16	9.50		Yes	No
GSA 6	*Nephrops norvegicus*	Norwegian lobster	VIT	0.59	0.15	3.93		No	No
GSA 7	*Merluccius merluccius*	Hake	a4a	1.67	0.17	9.82		Yes	No
GSA 7	*Mullus barbatus*	Red mullet	XSA	0.45	0.14	3.21		Yes	No
GSA 9	*Merluccius merluccius*	Hake	XSA	1.30	0.22	5.91		Yes	No
GSA 9	*Mullus barbatus*	Red mullet	XSA	0.70	0.60	1.17		Yes	No
GSA 9	*Micromesistius poutassou*	Blue whiting	XSA	0.38	0.32	1.19		Yes	No
GSA 9	*Nephrops norvegicus*	Norwegian lobster	XSA	0.43	0.21	2.05		Yes	No
GSA 17-18	*Engraulis encrasicolus*	Anchovy	SAM	1.04	0.50	2.08	0.92	Yes	Yes
GSA 17-18	*Sardina pilchardus*	Sardine	SAM	0.53	0.23	2.30	1.14	Yes	Yes
GSA 17	*Merluccius merluccius*	Hake	VIT	1.01	0.28	3.61		No	No
GSA 25	*Mullus barbatus*	Red mullet	SepVPA	NA	0.30	NA		No	No
GSA 25	*Mullus surmuletus*	Striped red mullet	SepVPA	NA	0.14	NA		No	No

STECF concludes that the EWG 14-09 adequately addressed the Terms of Reference and endorses the findings presented in the report.

REPORT TO THE STECF

EXPERT WORKING GROUP ON ASSESSMENT OF MEDITERRANEAN SEA STOCKS - PART 1 (EWG-14-09)

Rome, Italy, 14-18 July 2014

1 EXECUTIVE SUMMARY

The meeting was the first of two STECF expert meetings, within STECF's 2014 work programme, planned to undertake stock assessments of demersal/small pelagic species in the Mediterranean Sea. The meeting was organized by the Institute of Zoology, "La Sapienza" University, in Rome (Italy) from 14-18 of July 2013. The meeting was chaired by Massimiliano Cardinale and attended by 21 experts in total, including 4 STECF members plus 3 JRC experts (see Chapter 8).

Historic fisheries and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 15th 2014 with deadlines on 9th of June 2014. All concerned member states provided the requested data, although not always in respect of the deadline.

In fulfilment of TORs (a-c), the EWG 14-09 undertook the stock assessment of 15 stocks. 13 out of these 15 assessed stocks were classified as exploited unsustainably; the status of the remaining 2 stocks could not be defined.

Synoptic table of the stock assessed during EWG 14-09. In red are stocks for which current F is larger than F_{MSY}.

Stock area	Species	Common name	Assessment	F	F_{MSY}	F/F_{MSY}	B/B_{lim}	Short term	Medium term
GSA 6	*Merluccius merluccius*	Hake	XSA	1.48	0.15	9.87		Yes	No
GSA 6	*Mullus barbatus*	Red mullet	XSA	1.47	0.45	3.27		Yes	No
GSA 6	*Micromesistius poutassou*	Blue whiting	XSA	1.52	0.16	9.50		Yes	No
GSA 6	*Nephrops norvegicus*	Norwegian lobster	VIT	0.59	0.15	3.93		No	No
GSA 7	*Merluccius merluccius*	Hake	a4a	1.67	0.17	9.82		Yes	No
GSA 7	*Mullus barbatus*	Red mullet	XSA	0.45	0.14	3.21		Yes	No
GSA 9	*Merluccius merluccius*	Hake	XSA	1.30	0.22	5.91		Yes	No
GSA 9	*Mullus barbatus*	Red mullet	XSA	0.70	0.60	1.17		Yes	No
GSA 9	*Micromesistius poutassou*	Blue whiting	XSA	0.38	0.32	1.19		Yes	No
GSA 9	*Nephrops norvegicus*	Norwegian lobster	XSA	0.43	0.21	2.05		Yes	No
GSA 17-18	*Engraulis encrasicolus*	Anchovy	SAM	1.04	0.50	2.08	0.92	Yes	Yes
GSA 17-18	*Sardina pilchardus*	Sardine	SAM	0.53	0.23	2.30	1.14	Yes	Yes
GSA 17	*Merluccius merluccius*	Hake	VIT	1.01	0.28	3.61		No	No
GSA 25	*Mullus barbatus*	Red mullet	SepVPA	NA	0.30	NA		No	No
GSA 25	*Mullus surmuletus*	Striped red mullet	SepVPA	NA	0.14	NA		No	No

Following TOR (c), the EWG 14-09 also conducted short term forecasts of stock size and catches for 11 stocks and medium term forecast for two stocks.

In fulfilment of TOR (d), stock specific evaluation of the data quality were conducted for all stocks requested under ToR (a-c) by the EWG 14-09 experts. Moreover, JRC team examined the data coverage and quality for the fisheries and survey data. This was performed by means of data exploration and the MEDITS SQL quality checks developed by JRC. Results of the evaluations are reported under chapter 5 - ToR (d) and at the end of the assessment section of each stock. Data coverage was not always complete in the latest data call: France did not provide any fisheries data for GSA 8 (Corsica); moreover effort data for all French GSA's are absent prior to 2012. Italy in general did not provide any fisheries data prior to 2005. Apparently, lack of specific Croatian data for 2012 and 2013 did not allow the EWG to apply an analytical methodology for assessing hake in the North Adriatic. Additionally, officially submitted sardine landings data from Croatia was not used during EWG 14-09; experts identified them as incorrect and used their own 'correct' data. As a result of not conducting DCF, Greece did not submit any data for 2009-2012 and submitted only last quarter of 2013. Due to this gap in data, stock assessment (except small pelagics) seems unlikely to be performed for any demersal species in the next 2-3 years. More detailed issues identified in the data are described in the stock assessment sections. In addition TOR (d) section includes a more extended data coverage/quality evaluation, reporting on all data collected under the 2014 Data Call and not only those related to the stocks assessed.

This EWG report will be presented and reviewed during the STECF winter plenary meeting PLEN 14-03, 10-14 November 2014.

2 INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment STECF EWG 14-09 held its first meeting planned for 2014 in Rome (Italy), 14-18 July 2014.

The chairman opened the meeting at 09:00 on Monday, 14 July 2014, and adjourned the meeting by 13.00 on Friday, 18 July 2014. The meeting was attended by 21 experts in total, including 4 STECF members and an additional 3 JRC experts.

The structure of the present report is in accordance with the terms of reference to STECF, as defined in the following chapter.

3 TERMS OF REFERENCE FOR EWG-14-09

The STECF 14-09 was requested to:
STECF is requested to:
a) update and assess, by all relevant individual GSAs or combined GSAs where possible and where sound scientific basis exists (e.g. STOCKMED project), historic and recent stock parameters for the longest time series possible of the stocks given in Table 1. Monkfish assessment will be considered in the January 2015 session of this working group but STECF is requested to clarify if there are any reasons impeding this assessment (lack of data, reliability, and poor quality of data).

Taking into account the repartition of catches among countries (GFCM capture database; DCF, etc) and including also their likely exploitation patterns (STECF analyses, GFCM-SAC assessment forms; FAO regional projects, scientific papers, etc), indicate whether an assessment carried out with only EU catch data can still be considered scientifically sound.

Due account shall be given to technical interactions and description of the multispecies and multiple-gears fisheries concerned in terms of exploitation pattern, deployed fishing effort (trends over time) and allocation of stock catches among different métiers.

To the extent possible, the assessment shall provide the target (biological, bio-economic), the precautionary (threshold) and conservation (limit) reference points, either model based or empirical. The reference points shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels maintain or restore marine biological resources at least at levels which can produce the maximum sustainable yield.

Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on April and reminded in May 2014.

Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary and following quality check. Due account shall also be given to data used and assessments carried out within the FAO regional projects co-funded by the European Commission and EU-Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

Raw data used to generate the input data, assessment scripts as well as input files need to be made available for reproducibility of the assessments and documentation.

However, in case that an assessment with the most recent data has been already carried out and/or endorsed by the GFCM-SAC for the same stock(s) and fisheries, there is no need to redo the analyses unless new scientific and fishery elements have emerged that call for a revised assessment. A revision of a GFCM-SAC assessment has to be conducted only if raw data to generate the input data for the assessment are made available to the STECF-EWG the first day of the meeting at latest.

b) Provide a synoptic overview of all stocks mentioned in Tables 1 and 2 on the recent status of exploitation level and stock size of the stocks listed under a) in relation to the biological fisheries management reference points including information on the fisheries minimum sizes at first capture corresponding, where possible, to 0%; 25% and 50 % below the minimum sizes.

*__Table 1.__ Priority stocks.

Species proposed	**GSA(s) proposed**	**Last year available in stock assessment, by STECF or SAC**	**PRIORITY**	
			Species	**Area**
Merluccius merluccius	GSA 6	2011	1	1
Mullus barbatus	GSA 6	2012	1	1
Micromesistius poutassou	GSA 6	2011	1	1
Nephrops norvegicus	GSA 6	2011	2	1
Merluccius merluccius	GSA 7	2012	1	1
Mullus barbatus	GSA 7	2012	1	1
Merluccius merluccius	GSA 9	2010	1	2
Micromesistius poutassou	GSA 9	2011	1	2
Mullus barbatus	GSA 9	2011	1	2
Nephrops norvegicus	GSA 9	2010	2	2
Engraulis encrasicolus	GSA 17-18	2012 (GSA 17)	1	1
Sardina pilchardus	GSA 17-18	2012 (GSA 17)	1	1
Merluccius merluccius	GSA 17	2011	1	1
Mullus barbatus	GSA 25	2010	1	2

Species proposed	GSA(s) proposed	Last year available in stock assessment, by STECF or SAC	PRIORITY	
			Species	Area
Mullus surmuletus	GSA 25	2010	1	2

*List of stocks as decided after discussion with the experts and DG MARE representatives during the first session of the EWG 14-09.

Table 2. Additional stocks.

Species proposed	GSA(s) proposed	Last year available in stock assessment, by STECF or SAC	PRIORITY	
			Species	Area
Trachurus Trachurus	GSA 6-7	---	2	1
Octupus vulgaris	GSA 6-7	---	2	1
Aristeus antennatus	GSA 6-7	2011	2	1
Dicentrarchus labrax	GSA 7	---	2	1
Trachurus trachurus	GSA 7	---	2	1
Pagellus erythrinus	GSA 9	2010	2	2
Aristeus antennatus	GSA 9	2010	1	2
Merluccius merluccius	GSA 15-16	2012	1	1
Parapenaeus longirostris	GSA 15-16	2012	1	1
Mullus barbatus	GSA 15-16	2011 (GSA 15-16)	1	1
Aristaeomorpha foliacea	GSA 15-16	2010 (GSA 15-16)	2	1
Aristaeomorpha foliacea	GSA 19	---	2	2
Parapenaeus longirostris	GSA 19	2012	1	2
Mullus barbatus	GSA 19	2012	1	2
Merluccius merluccius	GSA 19	2012	1	2
Aristaeomorpha foliacea	GSA 20	---	2	2
Parapenaeus longirostris	GSA 20	---	1	2
Mullus barbatus	GSA 20	2007	1	2
Merluccius merluccius	GSA 20	2007	1	2
Parapenaeus longirostris	GSA 22-23	---	1	2
Mullus barbatus	GSA 22-23	2007	1	2
Merluccius merluccius	GSA 22-23	2007	1	2

c) provide for each of the 15 priority stocks a short term and a medium term forecast (medium term forecast only when an acceptable Stock/Recruitment empirical/model based relationship is identifiable) of stock biomass and yield for the demersal stocks assessed in this meeting (Tor a) including, where advisable, assessments carried out in scientific frameworks other than STECF. The forecast scenarios shall include, inter alia:

the status quo
and
target to F_{msy} *or other appropriate proxy for 2015 and 2020 respectively*.

Whenever the quality of the data series allows it (time series of available data should ideally exceed the life span of a species assessed, values are not largely fluctuating among years, no data are missing for certain fleets/metiers among years, no data lacking in large part of the age classes), please produce catch forecasts to get high yield under different recruitment scenarios while avoiding with high probability the risk that SSB fall under Blim. In particular:

1) Estimate the biomass reference points (i.e. $SSB_{trigger}$ both as SSB_{lim} and SSB_{pa}) defined as the levels of SSB below which recruitment is considered likely to become increasingly impaired and thus actions should be taken (i.e. reducing fishing mortality below F_{MSY}) when the SSB approaches such stock sizes.

2) Using the framework developed at ICES-WKFRAME 2010 adopted in the STECF EWG 12-13 and when the appropriate time series is available, estimate the levels of F which minimize the risk of SSB falling below $SSB_{trigger}$ or crashing the stock and provide MSY or maximize the total yield from the stock in the long term.

3) Estimate on the basis of commercial average catch rates by métier, the level of fishing effort by métier which is commensurate to the sustainable short-term and medium-term forecasts.

Implications of the proposed changes in fishing mortality on the fishing effort exerted by the relevant fisheries/métier concerned should be identified or qualitative addressed. The identification and description of fisheries/métier (DCF codification) to be considered are left to the experts on the basis of their knowledge of fisheries in each GFCM-GSA.

The simulation by fishery for the abovementioned targets shall be driven either by the most relevant stock(s) (either in quantity and/or economic value), or the most vulnerable stock or a scientifically weighed mix of MSY targets for the main species involved in the fishery.

Raw data used to generate the input data for the assessment shall be made available to allow for testing different settings and data scenarios.

d) review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2014. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based the data format of the official DCF data calls for the Mediterranean issued on April 2014.

4 TOR A-B UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

A) Update and assess, by all relevant individual GSAs or combined GSAs where possible and where sound scientific basis exists (e.g. STOCKMED project), historic and recent stock parameters for the longest time series possible of the stocks given in Table 1. Monkfish assessment will be considered in the January 2015 session of this working group but STECF is requested to clarify if there are any reasons impeding this assessment (lack of data, reliability, and poor quality of data).

B) Provide a synoptic overview of all stocks mentioned in Tables 1 and 2 on the recent status of exploitation level and stock size of the stocks listed under a) in relation to the biological fisheries management reference points including information on the fisheries minimum sizes at first capture corresponding, where possible, to 0%; 25% and 50 % below the minimum sizes.

4.1 SUMMARY SHEETS

4.1.1 SUMMARY SHEET OF HAKE IN GSA 6

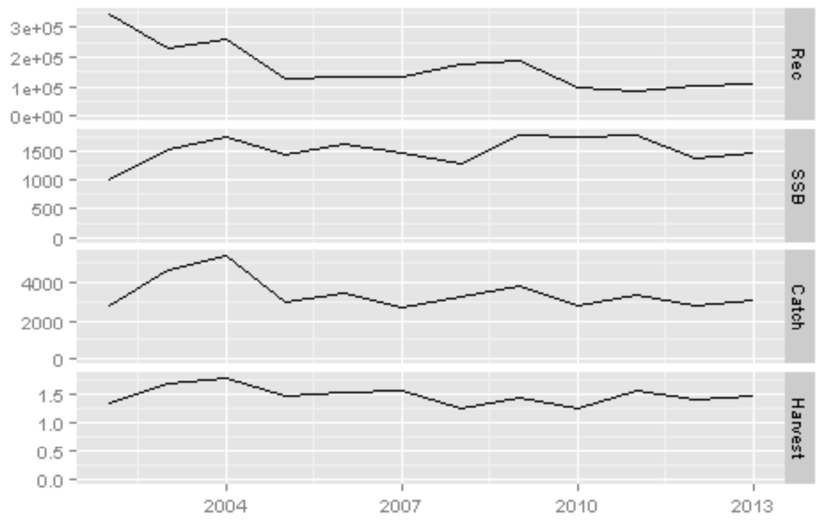
Species common name: European hake
Species scientific name: *Merluccius merluccius*
Geographical Sub-area(s) GSA(s): 6

4.1.1.1 Most recent state of the stock

State of the adult abundance and biomass
SSB oscillated around 1500 t in the period 2002-2013, with a peak in 2011 (1782 t) and a minimum in 2002 (1013 t). No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)
Recruitment declined from about 300 to 100 10^6 individuals during the analysed period.

State of exploitation
The current F (1.48) is larger than F_{MSY} (0.15), which indicates that hake in GSA 6 is exploited unsustainably.



Hake in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.1.2 Outlook and management advice
EWG 14-09 advise the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock

productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects

4.1.1.3 Fisheries

Hake is one of the most important target species for the trawl fisheries in GSA 6. It is also caught by longliners, and gill and trammel netters. The annual landings of this species, which are mainly composed by juveniles caught on the continental shelf, fluctuated around 3100 tonnes since 2005. Landings by fishing gears other than bottom trawl represent less than 10% of the annual total cacthes during 2002- 2013, except in 2006-2007 (i.e. around 15%).

The trawl fleet in GSA 6 has been decreasing over the last 10 years, from around 670 vessels in 2004-2005 to 540 in 2012.

4.1.1.4 Limit and precautionary management reference points

Limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.15

4.1.1.5 Comments on the assessment

The detailed assessment of hake in GSA 6 can be found in section 4.2.1.

4.1.2 SUMMARY SHEET OF RED MULLET IN GSA 6

Species common name: Red mullet
Species scientific name *Mullus barbatus*
Geographical Sub-area(s) GSA(s): 6

4.1.2.1 Most recent state of the stock

State of the adult abundance and biomass

The SSB showed a maximum of 1884 tons in 2003 and minimum values of 800-860 tons in 2008-2009, followed by an increasing trend and reaching the highest values in 2013 (2012 tons).

State of the juvenile (recruits)

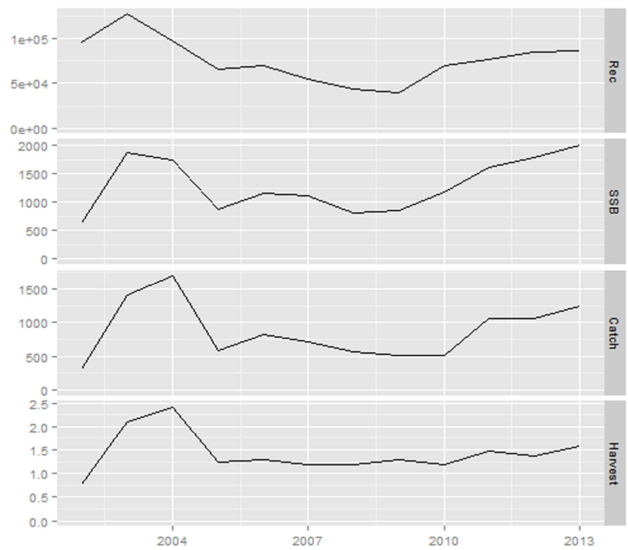
Recruitment showed a maximum of $127 \cdot 10^6$ individuals in 2003, followed by a decreasing trend and reaching a minimum of $39 \cdot 10^6$ individuals in 2009. An increase in recruitment was observed from 2009 to 2013.

State of exploitation

The current F (1.47) is larger than F_{MSY} (0.45), which indicates that red mullet in GSA 6 is exploited unsustainably.

Source of data and methods

Landings, tuning fleet (MEDITS survey) and size-frequency distributions for the period 2002-2013 are from the Official Data Call. Biological parameters are the same used in previous assessments of this stock (STECF EWG 13-19). XSA and projections were run using standard R scripts.



Red mullet in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.2.2 Outlook and management advice

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.2.3 Fisheries

Red mullet is caught in GSA 6 mainly by bottom trawlers fishing on the continental shelf, between 50 and 200 m depth. It is also caught by trammel nets, but in a lower proportion, representing in general less than 10% of the total catches.

4.1.2.4 Limit and precautionary management reference points

Limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.45.

4.1.2.5 Comments on the assessment

The detailed assessment of red mullet in GSA 6 can be found in sections 4.2.2.

4.1.3 SUMMARY SHEET OF BLUE WHITING IN GSA 6

Species common name: Blue whiting
Species scientific name: *Micromesistius poutassou*
Geographical Sub-area(s) GSA(s): 6

4.1.3.1 Most recent state of the stock

State of the adult abundance and biomass

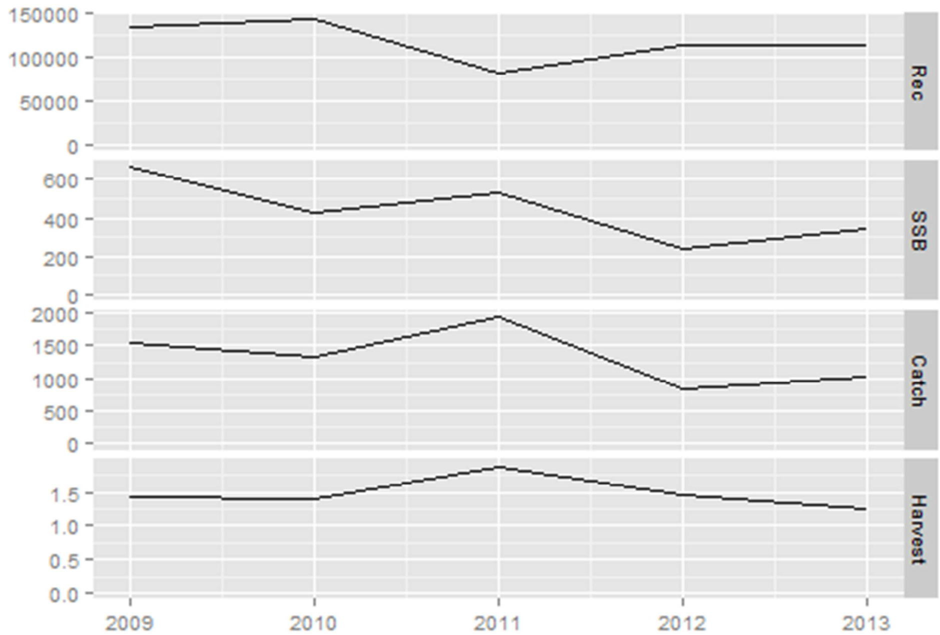
SSB declined during the period of 2009-2013, with a minimum in 2012. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass with respect to these.

State of the juvenile (recruits)

Recruitment fluctuated without trend over 2009-2013, with the highest values in 2010 and a minimum in 2011.

State of exploitation

The current F (1.52) is larger than F_{MSY} (0.16), which indicates that blue whiting in GSA 6 is exploited unsustainably. Exploitation is based on age classes 1 and 2, with age 0 not fully recruited to the fisheries.



Blue whiting in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

The stock of blue whiting in GSA 6 was assessed applying an Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). In addition, a yield-per-recruit (Y/R) analysis was carried out. Both mehods were performed from the size composition of trawl landings, transforming length data to ages by knife-edge slicing (L2AGE program).

Input data landings and length frequencies were taken from DCF. Von Bertalanffy growth parameters and length-weight relationship were taken from parameters estimated for blue whiting in GSA 9. Natural mortality (vector) was estimated using PROBIOM.

4.1.3.2 Outlook and management advice

EWG 14-09 advise the fleet effort and/or catches to be reduced until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings.

4.1.3.3 Fisheries

Blue whiting is a demersal species important locally, especially in the northern part of GSA 6 and it is mainly exploited by the otter trawlers. Over the period 2002-2013 annual landings oscillated around 2200 t. Trawl discards in weight are high, especially in the last three years (2011-2013) but there are not length frequencies in DCF associated to these discards. In the current stock assessment presented in section 3.2.3, discard were assumed to be 0.

4.1.3.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.16

4.1.3.5 Comments on the assessment

The detailed assessment of blue whiting in GSA 6 can be found in section 4.2.3

4.1.4 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 6

Species common name: Norway lobster
Species scientific name *Nephrops norvegicus*
Geographical Sub-area(s) GSA(s): 6

4.1.4.1 Most recent state of the stock

State of the adult abundance and biomass

Stock abundance showed values between 80-140·10^6 individuals, with a predominance of ages 1-3. SSB showed values between 300-600 t. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass with respect to these.

State of the juvenile (recruits)

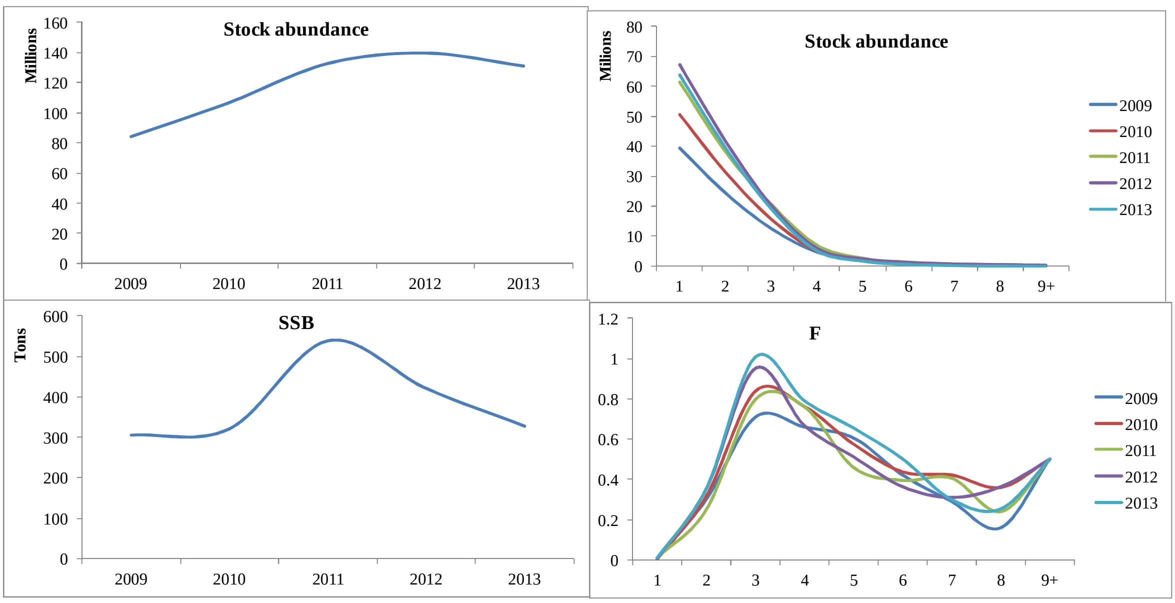
No information about recruitment is available.

State of exploitation

The current F (0.59) is larger than F_{MSY} (0.15), which indicates that Norway lobster in GSA 6 is exploited unsustainably.

Source of data and methods

Landings and size-frequency distributions for the period 2009-2013 are from the Official Data Call. Biological parameters are the same used in previous assessments of this stock (STECF EWG 12-19). The assessment was conducted using a pseudocohort analysis run using VIT.



***Norway lobster* in GSA 6.** VIT summary results. SSB is in tonnes, stock abundance in millions of individuals.

4.1.4.2 Outlook and management advice

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.4.3 Fisheries

Norway lobster is caught in GSA 6 exclusively by bottom trawlers fishing on the upper slope, between 350-600 m depth.

4.1.4.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.15.

4.1.4.5 Comments on the assessment

The detailed assessment of Norway lobster in GSA 6 can be found in section 4.2.4.

4.1.5 SUMMARY SHEET OF HAKE IN GSA 7

Species common name: Hake
Species scientific name : *Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s): 7

4.1.5.1 Most recent state of the stock

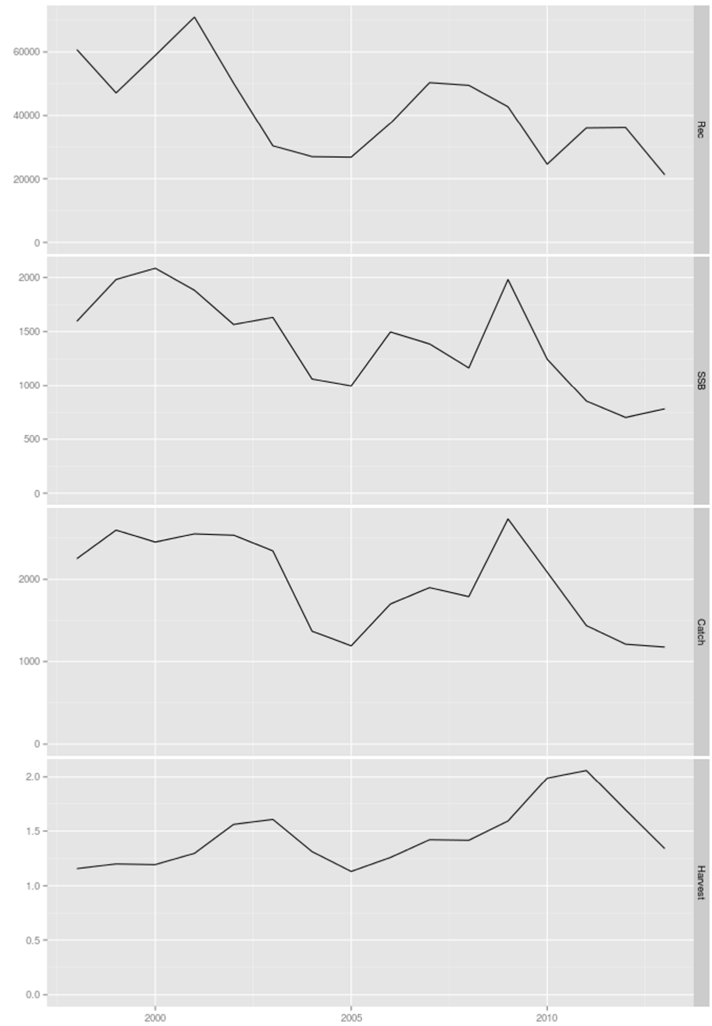
State of the adult abundance and biomass
The stock spawning biomass (SSB) shows a decreasing trend over the analyzed period. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass with respect to these.

State of the juvenile (recruits)
The highest recruitment values observed over the analysed period are in 1998, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and is currently at a low level.

State of exploitation
The current F (1.67) is larger than F_{MSY} (0.17), which indicates that hake in GSA 7 is exploited unsustainably. The exploitation is mainly concentrated on younger individuals.

Source of data and methods
Data coming from DCF (catch at age from the French and Spanish trawlers, French gillnetters and Spanish longliners) for the period 1998-2013 were used to run a statistical catch at age (a4a) analysis using the MEDITS abundance indices for 1998-2013 as tuning fleet. Discards were included in the catches. Growth parameters were derived from tagging experiments (Mellon et al., 2010) conducted in GSA 7 and from the Data Collection Framework (DCF) data call while natural mortality was estimated using PROBIOM (Abella 1997).

4.1.5.2 Outlook and management advice
STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.



Hake in GSA 7. A4a summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.5.3 Fisheries

Hake (*Merluccius merluccius*) is one of the most important demersal target species for the commercial fisheries in the Gulf of Lions (GSA 7). In this area, hake is exploited by French trawlers, French gillnetters, Spanish trawlers and Spanish long-liners. Since 1998, an average of 243 boats are involved in this fishery and, according to official statistics, the total annual landings for the period 1998-2013 have oscillated around an average value of 2008 tons (1690 tons in 2013). In 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species. Between 1998 and 2013, the number of French trawlers operating in the GSA 7 has decreased by 39%, while it decreased by 20% between 2010 and 2013. The French trawler fleet is the largest both for the number of boats and the realised catch (41% and 72%, respectively).

4.1.5.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.17.

4.1.5.5 Comments on the assessment

The detailed assessment of hake in GSA 7 can be found in section 4.2.5.

4.1.6 SUMMARY SHEET OF RED MULLET IN GSA 7

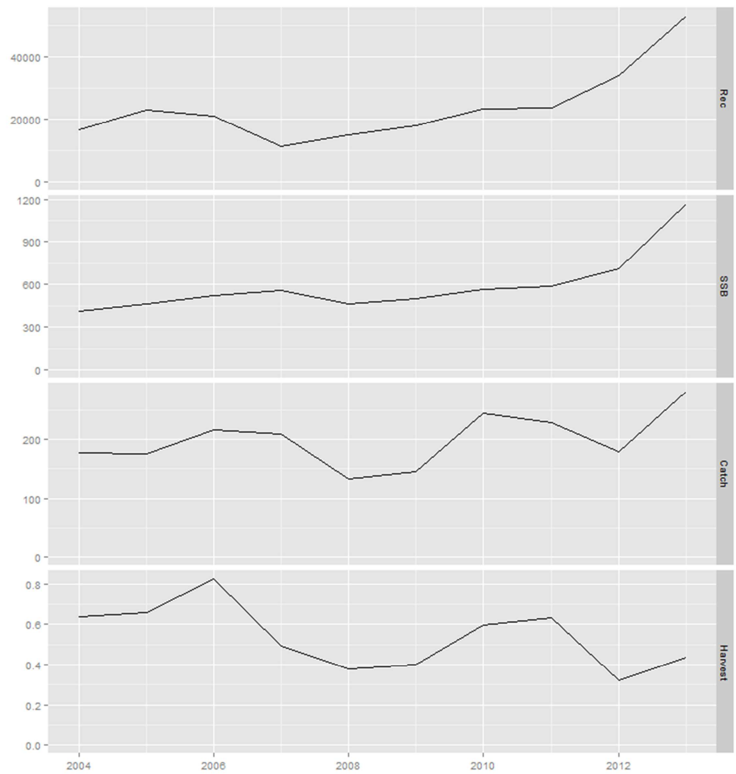
Species common name: Red mullet
Species scientific name *Mullus barbatus* (L., 1758)
Geographical Sub-area(s) GSA(s): 7

4.1.6.1 Most recent state of the stock

State of the adult abundance and biomass
The SSB shows an increasing trend since 2008. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass with respect to these.

State of the juvenile (recruits)
The recruitment shows an increasing trend over the period with the highest values observed in the very recent years.

State of exploitation
The current F (0.45) is larger than F_{MSY} (0.14), which indicates that red mullet in GSA 7 is exploited unsustainably. The exploitation is mainly concentrated on young individuals (age 0-2).



Red mullet in GSA 7. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

Data coming from DCF (catch at age from the French and Spanish trawlers, French gillnetters) for the period 2004-2013 were used to run an Extended Survivor Analysis (XSA), tuned with MEDITS abundance indices for 2004-2013. Discards were included in the catches. Growth parameters of red mullet (*Mullus barbatus*) in the Gulf of Lions was estimated with Von Bertalanffy growth curve (DCF) for the beginning of the data series (2004-2011) and then age length key (DCF) for the last two years (2012, 2013), while natural mortality was estimated using PROBIOM.

4.1.6.2 Outlook and management advice

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.6.3 Fisheries

In the Gulf of Lions (GFCM-GSA 7), red mullet (*Mullus barbatus*) is exploited by both french and spanish trawlers. Information on french gillnetters is only available for 2011 and 2013, but although it is suspected that they have been fishing red mullet in the past, no data is available to quantify their catches. Between 2004 and 2013, around 100 boats have been involved in the fishery. According to official statistics, during this period the total annual landings have oscillated around an average value of 200 tons and the french trawlers have been dominating the fishery, as they represent 83% of the catches (165 tons) on the period. Between 2010 and 2013 the number of trawlers decreased by 20% and it decreased by 50% over the 2004-2013 period. From a maximum number of 123 trawlers in 2004, the french fleet is nowadays composed by 61 units. This follows management measures to reduce the number of boats.

4.1.6.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.14.

4.1.6.5 Comments on the assessment

The assessment of red mullet in GSA 7 has been performed using 2 models : a4a and XSA. The general framework of a4a, by testing a large number of models, showed interesting potential to objectively assess this stock and test different hypotheses for biological parameters, catch and abundance indices data, and model specifications. The use of this would require further work and therefore XSA was kept as the final model for stock assessment of red mullet in GSA 7.

4.1.7 SUMMARY SHEET OF HAKE IN GSA 9

Species common name: European hake
Species scientific name *Merluccius merluccius*
Geographical Sub-area(s) GSA(s): 9

4.1.7.1 Most recent state of the stock

State of the adult abundance and biomass

In 2005-2013, the SSB was estimate to be between 790 and 1419 t with levels estimated in 2012-2013 lower to levels calculated for 2005-2011. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)

Recruitment ranged between 50 and 120 million in the period 2005-2013 with a decreasing trend over the analysed time series.

State of exploitation

The current F (1.30) is larger than F_{MSY} (0.22), which indicates that hake in GSA 9 is exploited unsustainably.

Source of data and methods

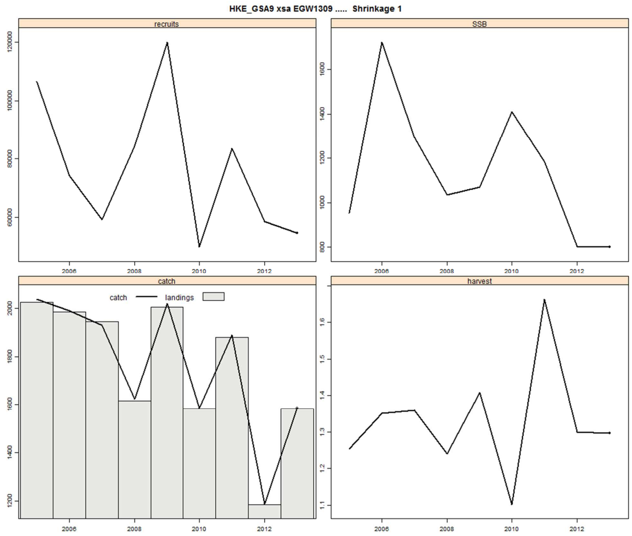
The state of exploitation was assessed for the period 2005-2013 applying an Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). In addition, a yield-per-recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of trawl and small-scale fishery landings, transforming length data to ages using the slicing statistical approach developed during STECF-EWG 11-12 (Scott et al., 2011). Input data were taken from DCF. Natural mortality vector was estimated using PRODBIOM.

4.1.7.2 Outlook and management advice

EWG 14-09 advise the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects.

4.1.7.3 Fisheries

Hake is one of the main target species of bottom trawlers in the GSA 9 in terms of landings, incomes and vessels involved. The analysis of available information suggests that about 50% of landings of hake are obtained by bottom trawl vessels, the remaining fraction being provided by artisanal vessels using set nets, in particular gillnets. The trawl fleet of GSA 9 accounted for 301 vessels in 2012 based in several ports: Viareggio, Livorno, Porto Santo Stefano, Civitavecchia, Fiumicino, Anzio, Terracina, Gaeta, Formia. They accomplish daily fishing trips exploiting both continental shelf and slope areas. Hake fishing grounds comprise all the soft bottoms of continental shelves and the upper part of continental slope. Fishing pressure shows a spatial pattern inside the GSA 9 according to the consistency of the fleets and the distance of the fishing grounds from the main ports. The artisanal fleets, according to the last official data (2012), accounted for 1266 vessels that operate in several harbours along the continental and insular coasts. Of these, about 40 vessels, mainly located in some harbors of the GSA 9 (e.g. Marina di Campo, Ponza, Porto Santo Stefano), utilize gillnets and target medium and large-sized hakes (larger than 25 cm TL), mainly from November to May. Since 2005 the total landings of hake of GSA 9 fluctuated between 1000 to 2176 tons (1341 in 2013).



Hake in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.7.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.22.

4.1.7.5 Comments on the assessment

The detailed assessment of hake in GSA 9 can be found in section 4.2.7.

4.1.8 SUMMARY SHEET OF RED MULLET IN GSA 9

Species common name: Red mullet
Species scientific name *Mullus barbatus*
Geographical Sub-area(s) GSA(s): 9

4.1.8.1 Most recent state of the stock

State of the adult abundance and biomass

The SSB shows a slight decrease, with a mean value of about 2171 (t) in the period 2006-2013. Nevertheless, due to the absence of proposed or agreed biomass management reference points, the EWG 14-19 is unable to fully evaluate the state of the spawning stock in respect to these.

State of the juvenile (recruits)

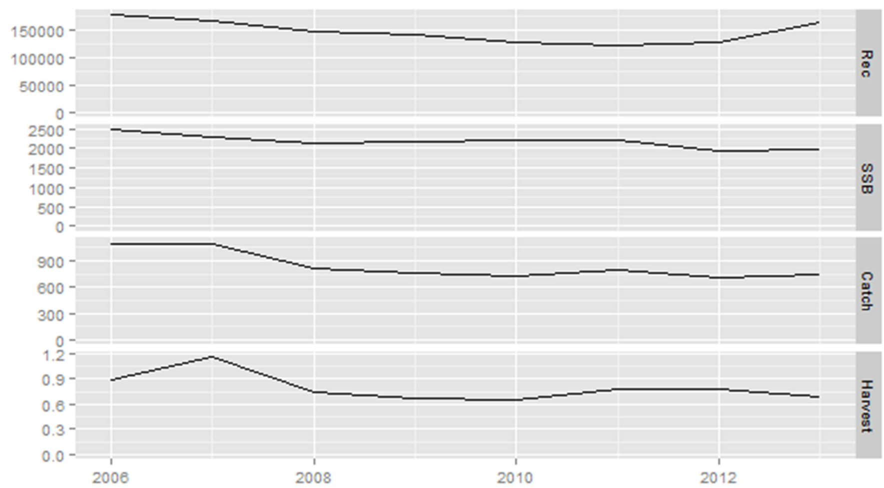
According to the XSA analyses, the recruitment of red mullet in GSA 9 is stable around a mean value of about 146175 (thousands individuals).

State of exploitation

The current F (0.70) is larger than F_{MSY} (0.60), which indicates that red mullet in GSA 9 is exploited unsustainably.

Source of data and methods:

Data from DCF provided at EWG 14-19 containing information on red mullet landings and the respective age structure for 2006-2013 were used. A vector of natural mortality value by age was obtained applying PRODBIOM. Catch at age, weight at age, mortality at age and maturity at age data for the 2006-2013 period were compiled for age classes 0 to 4. Tuning was performed using trawl surveys abundance indices (MEDITS). Yield per Recruit analysis was performed for the estimation of the reference point.



Red mullet in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.8.2 Outlook and management advice

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.8.3 Fisheries

The stock is mainly exploited by trawlers in the depth range 10-100m. They exploit a mixed species assemblage where red mullet is an important component. Small scale vessels exploitation of the stock using trammel nets and gillnets is very modest, but official data suggest an increase in catches in recent years. Annual landings, mostly proceeding from trawling, ranged from 1050 to 693 tons from 2006 and 2013. Discards of undersized individuals is in general small (10% in weight was estimated in 2006).

4.1.8.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.60.

4.1.8.5 Comments on the assessment

The detailed assessment of red mullet in GSA 9 can be found in section 4.2.8.

4.1.9 SUMMARY SHEET OF BLUE WHITING IN GSA 9

Species common name: Blue whiting
Species scientific name *Micromesistious poutassou*
Geographical Sub-area(s) GSA(s): 9

4.1.9.1 Most recent state of the stock

State of the adult abundance and biomass

SSB showed a stable trend, varying around a mean value of about 260 t in the period 2009-2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)

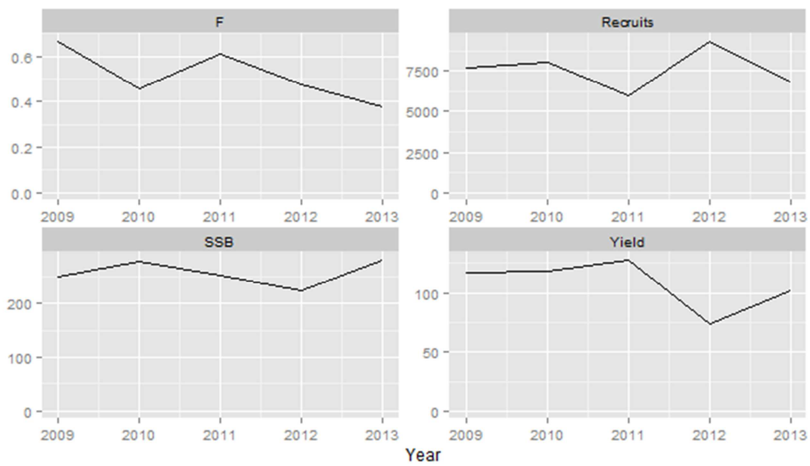
The recruitment of blue whiting in GSA 9 fluctuated around a mean value of about 7613 thousands individuals without a clear pattern over the time period.

State of exploitation

The current F (0.38) is larger than $F_{0.1}$ (0.32), which indicates that blue whiting in GSA 9 is exploited unsustainably.

Source of data and methods

Data from DCF provided at EWG 14-09 containing information on blue whiting landings and the respective age structure for 2009-2013 were used. A vector of natural mortality value by age was obtained applying PRODBIOM. Catch at age, weight at age, mortality at age and maturity at age data for the 2009-2013 period were compiled for age classes 0 to 4+ tuned with fishery independent abundance indices (MEDITS survey) were used as input data for the XSA. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of F_{01} (i.e. proxy of F_{MSY}). The computation was made by R project software and the FLR libraries.



Blue whiting in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

4.1.9.2 Outlook and management advice

EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

4.1.9.3 Fisheries

Blue whiting represent an important by-catch resource for the otter trawling fleet operating on the slope over muddy bottoms and the highest biomass is found on epibathyal fishing grounds. Fishery independent data (MEDITS survey) showed in the northern part of the area the highest abundance.

4.1.9.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.32.

4.1.9.5 Comments on the assessment

The detailed assessment of blue whiting in GSA 9 can be found in section 4.2.9.

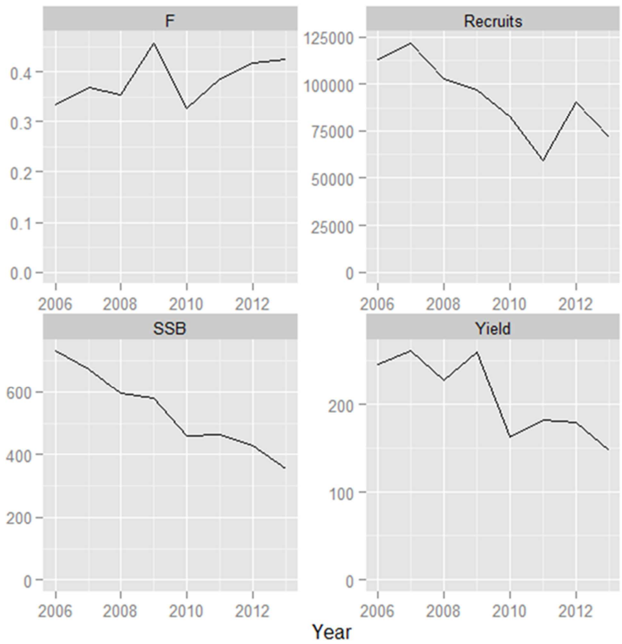
4.1.10 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 9

Species common name: Norway lobster
Species scientific name *Nephrops norvegicus*
Geographical Sub-area(s) GSA(s): 9

4.1.10.1 Most recent state of the stock

State of the adult abundance and biomass

SSB decreased in the period analised, from about 730 tons in 2006 to 355 tons in 2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.



Norway lobster in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

State of the juvenile (recruits)

Recruits showed an evident decreasing trend from 2007 to 2011 and fluctuations in the last years.

State of exploitation

The current F (0.43) is larger than F_{MSY} (0.21), which indicates that Norway lobster in GSA 9 is exploited unsustainably.

Source of data and methods

An XSA analysis was performed using 2006-2013 DCF data (biomass landed and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

4.1.10.2 Outlook and management advice

STECF EWG 14-09 advise the fisheries effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by reducing fishing effort of the relevant fleets by means of a multi-annual management plan taking into account mixed-fisheries effects.

4.1.10.3 Fisheries

Norway lobster is one of the most important commercial species in the GSA 9 for total annual landing and economic value. All the landing is due to bottom trawl vessels exploiting slope muddy bottoms, mainly between 300 and 500 m depth. Catch of vessels targeting Norway lobster is composed of a mix of both commercial (hake, deep sea pink shrimp, horned octopus (*Eledone cirrhosa*), squids (*Todaropsis eblanae*)), and non-commercial species. The trawl fleet of GSA 9 accounts for about 350 trawlers. To date about 80-100 of them are involved in this fishery. In the last eight years the total landing of Norway lobster in GSA 9 showed an evident decreasing trend, from a maximum of 260 tons in 2007 to 148 tons in 2013. The catch is mainly composed by adult individuals over the size at first maturity, while discarding of specimens under the Minimum Conservation Size (20 mm CL) is negligible.

4.1.10.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is F_{MSY} = 0.21.

4.1.10.5 Comments on the assessment

The detailed assessment of Norway lobster in GSA 9 can be found in section 4.2.10.

4.1.11 SUMMARY SHEET OF ANCHOVY IN GSA 17-18

Species common name: Anchovy
Species scientific name *Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s): 17-18

4.1.11.1 Most recent state of the stock

State of the spawning stock size

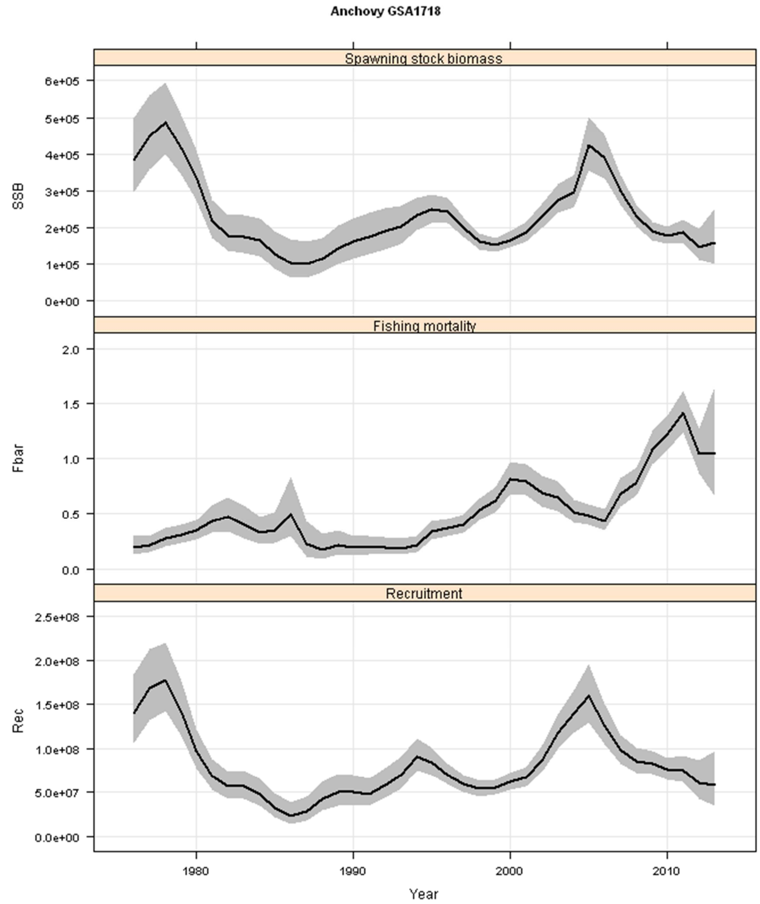
The assessment model (SAM) shows a declining trend in SSB starting after a peak observed in 2005 (SSB = 422900 tons), reaching in 2013 a SSB biomass level of around 158900 tons. The level of anchovy SSB in 2013 (SSB excluding age 0 = 38961) is lower than the estimated reference point for B_{lim} (B_{lim} excluding age 0 = 42546 t).

State of recruitment

SAM model estimates shown fluctuations in recruitment from a minimum value in 1986, to a maximum value in 1978. A second peak was observed in 2005, with a value of about 158900 millions of individuals.

State of exploitation

Based on SAM results, F increased from 1994, with a first peak in 2000 (F = 0.8) and a second peak in 2011 (F = 1.4). In the last two years the F decreases to a value equal to 1.0. The current F (1.04) is larger than F_{MSY} (0.50), which indicates that anchovy in GSA 17-18 is exploited unsustainably.



Anchovy in GSA 17-18. SAM summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods
The stock of anchovy was asssessed using the State-space Assessment Model (SAM) (Nielsen et al., 2012) in FLR environment with data from 1975 to 2013. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. Three tuning indices (two acoustic surveys covering respectively the western and eastern GSA 17, and one acoustic survey covering the western GSA 18) from 2004 to 2013 were used in the assessment.

4.1.11.2 Outlook and management advice
STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.11.3 Fisheries

Anchovy is commercially very important in the Adriatic Sea: it is targeted by pelagic trawlers (Italy) and purse seiners (Italy, Croatia, Slovenia, Montenegro, Albania). Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17.

4.1.11.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.50 and B_{lim} (excluding age 0 individuals) = 42550 t.

4.1.11.5 Comments on the assessment

The detailed assessment of anchovy in GSA 17-18 can be found in section 4.2.11.

4.1.12 SUMMARY SHEET OF SARDINE IN GSA 17-18

Species common name: Sardine
Species scientific name *Sardina pilchardus*
Geographical Sub-area(s) GSA(s): 17-18

4.1.12.1 *Most recent state of the stock*

State of the spawning stock size

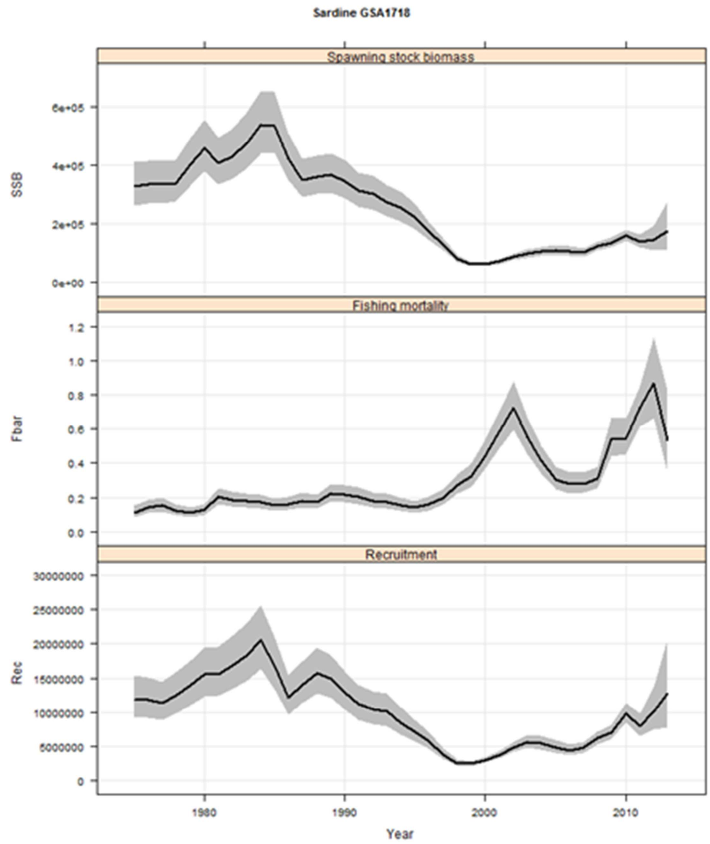
Results of the assessment model (SAM) indicated a constant increase in total biomass starting in the late nineties, with almost stable values in the last 5 years, and a value of about 336000 tons in 2013. The same trend is reflected in the estimated spawning stock biomass mid-year that is equal to 174905 tons in 2013. The biomass of sardine in 2013 (mid year SSB = 174900 t) is above the B_{lim} reference point estimated through the medium term projection (B_{lim} = 153500 t).

State of recruitment

After the drop in recruitment occurred from 1985 to 1998, the recruitment level (corresponding to age 1 in the model) is constantly increasing. In 2013 recruitment reaches the highest value after the peak in 1984, with 12698 millions specimens.

State of exploitation

The current F (0.53) is larger than F_{MSY} (0.23), which indicates that sardine in GSA 17-18 is exploited unsustainably.



Sardine in GSA 17-18. SAM summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

The stock of sardine was asssessed using the State-space Assessment Model (SAM) (Nielsen et al., 2012) in FLR environment with data from 1975 to 2013. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. Three tuning indices (two acoustic surveys covering respectively the western and eastern GSA 17, and one acoustic survey covering the western GSA 18) from 2004 to 2013 were used in the assessment.

4.1.12.2 Outlook and management advice

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.12.3 Fisheries

Sardine is commercially very important in the Adriatic Sea: it is targeted by pelagic trawlers (Italy) and purse seiners (Italy, Croatia, Slovenia, Montenegro, Albania). Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17.

4.1.12.4 Limit and precautionary management reference points
The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.23 and B_{lim} (excluding age 0 individuals) = 153507 t.

4.1.12.5 Comments on the assessment
The detailed assessment of sardine in GSA 17-18 can be found in section 4.2.12.

4.1.13 SUMMARY SHEET OF HAKE IN GSA 17

Species common name:	European Hake
Species scientific name:	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	17

4.1.13.1 Most recent state of the stock

State of the spawning stock size
EWG 14-09 is unable to provide any scientific advice of the state of the SSB given the preliminary state of the data and analyses.

State of recruitment
EWG 14-09 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

State of exploitation
The current F (1.01) estimated by VIT model for 2013 is larger than F_{MSY} (0.28), which indicates that hake in GSA 17 is exploited unsustainably. The overall fishing mortality in 2013, according to VIT model, is divided in 0.58 due to Italian OTB and 0.43 due to Croatian OTB.

Source of data and methods
In the Adriatic, hake is mainly fished with bottom trawl nets, but long-lines and gill-net are also used in the eastern side of the basin. According to the FAO statistics (www.fao.org/fishery/statistics/software/fishstatj/en), in the Adriatic Sea, the annual landings of hake in the 1980s and 1990s were estimated at around 2,000-4,000 t, with some peaks over 5,000 tons. A decreasing trend occurred from 1993 to 2000, followed by a positive trend. The analyses have been performed according to steady state VPA using VIT program (Lleonart and Salat, 1992) only on 2013, because of inconsistencies and incompleteness of data in DCF for 2012 (see Data quality paragraph 3.2.13.9).

4.1.13.2 Outlook and management advice
STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and

landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.1.13.3 Fisheries

The fisheries for hake are one of the most important in the GSA 17. Fishing grounds mostly correspond to the distribution of the stock (SEC (2002) 1374). In GSA 17 hake is a target species for the Italian and Croatian otter trawlers as well as Croatian long liners, but also in smaller quantity in the gill-net Croatian fisheries.

4.1.13.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.28.

4.1.13.5 Comments on the assessment

The detailed assessment of hake in GSA 17 can be found in section 4.2.13.

4.1.14 SUMMARY SHEET OF RED MULLET IN GSA 25

Species common name: Red mullet
Species scientific name *Mullus barbatus*
Geographical Sub-area(s) GSA(s): GSA 25

4.1.14.1 Most recent state of the stock

State of the adult abundance and biomass
The results of the separable VPA showed a slight increase in spawning stock biomass from 2010 to 2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)
The separable VPA showed a sharp decrease of recruitment in 2013. However, it is important to notice that MEDITS surveys are usually carried out in June-July in GSA 25, which is too early to sample juveniles adequately.

State of exploitation
EWG 14-09 proposed F_{MSY} = 0.30 as a management reference point for red mullet in GSA 25. However since the assessment is only indicative of trends, the current exploitation rate of red mullet in GSA 25 in comparison with the management reference point is unknown and thus EWG 14-09 was not able to assess the state of exploitation in respect to this.

Source of data and methods
Due to the lack of tuning file for red mullet in GSA 25, EWG 14-09 applied a separable VPA method to evaluate the status of this stock.

Official DCF data of commercial catches were used and the analysis was carried out using sex combined data. The annual size distributions of GSA 25 catches at age (from age reading) were used as well as the von Bertalanffy growth function estimates by Charilaou (2011). Maturity at age data was based on the information given in Charilaou (2011) and natural mortality at age was calculated with the PRODBIOM method. Weight at age information for catches was based on available official data for the years 2005-2013.

The reference age chosen to run the separable VPA was the one most represented in the catch (i.e. age 1). A sensitivity analysis on the results with $F_{terminal}$ values 0.10, 0.25 and 0.73 was been performed. The management reference point F_{MSY} was estimated based on all three model runs and the same result was obtained.

4.1.14.2 Outlook and management advice

EWG 14-09 proposes F_{MSY} = 0.30 as management reference point of exploitation consistent with high long term yield. However, as the assessment is only indicative of trends, EWG 14-09 was not able to provide a short term forecast for this stock.

4.1.14.3 Fisheries

Red mullet in GSA 25 is exploited by the artisanal fleet using set nets (basically trammel nets - GTR) and by the bottom otter trawlers - OTB. In both fisheries the species is exploited with a number of other demersal species, including *Sparisoma cretense*, *Octopus vulgaris*, *Sepia officinalis*, *Serranus cabrilla*, *Scorpaena* spp., Labridae, *Diplodus* spp., *Boops boops*, *Pagellus erythrinus*, *Siganus* spp. (Charilaou, 2011). On average 51% of total red mullet landings in GSA 25 came from bottom otter trawlers in 2005-2013. The remaining catches came from small-scale vessels measuring up to a maximum length overall (LOA) of 12 m using trammel nets (gear code GTR). Total red mullet landings in the period 2005-2013 decreased from 43.52 tonnes in 2005 to 23.7 tonnes in 2013. Landings of red mullet recorded in 2012 were at the lowest level recorded in the time series with 15.18 tonnes. The decrease in catches until 2012 was observed both for vessels using trammel nets (from 25.28 tonnes in 2005 to 8.54 tonnes in 2012) and for vessels using bottom otter trawlers (from 18.25 tonnes in 2005 to 6.65 tonnes in 2012). For both fishing categories an increase in landings was observed in 2013 (12 tonnes using trammel nets and 11.7 tonnes using bottom otter trawlers) compared to 2012 with 8.54 tonnes and 6.65 tonnes respectively.

4.1.14.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.30.

4.1.14.5 Comments on the assessment

The detailed assessment of red mullet in GSA 25 can be found in section 4.2.14.

4.1.15 SUMMARY SHEET OF STRIPED RED MULLET IN GSA 25

Species common name: Striped red mullet
Species scientific name *Mullus surmuletus*
Geographical Sub-area(s) GSA(s): 25

4.1.15.1 Most recent state of the stock

State of the adult abundance and biomass

The results of the separable VPA showed a slight increase in spawning stock biomass from 2009 to 2012, followed by a small decrease in 2013. However, in the absence of reliable survey data for this stock, the current assessment should be considered indicative of trends only. Moreoever, no precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)

The separable VPA showed a sharp decrease of recruitment in recent years. However, it is important to notice that, MEDITS surveys are usually carried out in June-July in GSA 25, which is too early to sample juveniles.

State of exploitation

EWG 14-09 proposed F_{MSY} = 0.14 as a management reference point for the striped red mullet in GSA 25. However since the assessment is only indicative of trends, the current exploitation rate of striped red mullet in GSA 25 in comparison with the management reference point is unknown and thus EWG 14-09 was not able to assess the state of exploitation in respect to this.

Source of data and methods

Due to the lack of reliable information from MEDITS survey data, EWG 14-09 applied a separable VPA method to evaluate the status of this stock.

Official DCF data of commercial catches were used and the analysis was carried out using sex combined data. The annual size distributions of GSA 25 catches were converted into numbers at age using the age slicing routine developed by Jardim et al. (2014) and the von Bertalanffy growth function estimates given in Charilaou (2011). Maturity at age data was based on the information given in Charilaou (2011) and natural mortality at age was calculated with the PRODBIOM method. Weight at age information for catches was based on available official data for the years 2005-2010.

The reference age chosen to run the separable VPA was the one most represented in the catch (i.e. age 1). A sensitivity analysis on the results with $F_{terminal}$ values 0.06, 0.12 and 0.18 was been performed. The management reference point F_{MSY} was estimated based on all three model runs and the same result was obtained.

4.1.15.2 Outlook and management advice

EWG 14-09 proposes F_{MSY} = 0.14 as management reference point of exploitation consistent with high long term yield. However, as the assessment is only indicative of trends, EWG 14-09 was not able to provide a short term forecast for this stock.

4.1.15.3 Fisheries

Striped red mullet is mainly fished by the artisanal fleet using set nets (in particular trammel nets), and by bottom otter trawlers in GSA 25. On average 93% of total striped red mullet landings in GSA 25 came from small scale vessels measuring up to a maximum length overall (LOA) of 12 m using trammel nets (gear code GTR) in 2005-2013.

Total striped red mullet landings in the period 2005-2013 decreased from 70 tonnes in 2005 to 22 tonnes in 2013; landings recorded in 2013 were at the lowest level recorded in the time series. The decrease in catches was observed both for vessels using trammel nets (from 62 tonnes in 2005 to 21 tonnes in 2013) and for vessels using bottom otter trawlers (from 8.5 tonnes in 2005 to 1.2 tonnes in 2013). For trawlers a slight increase in landings was observed in 2013 (1.2 tonnes) compared to 2011 (0.2 tonnes) and 2012 (0.3 tonnes).

4.1.15.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-09 is: F_{MSY} = 0.14.

4.1.15.5 Comments on the assessment

The detailed assessment of striped red mullet can be found in section 4.2.15.

4.2 STOCK ASSESSMENT

4.2.1 Stock Assessment of hake in GSA 6

4.2.1.1 Stock Identification

Due to the lack of information about the structure of hake (*Merluccius merluccius*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries (Fig. 4.2.1.1).

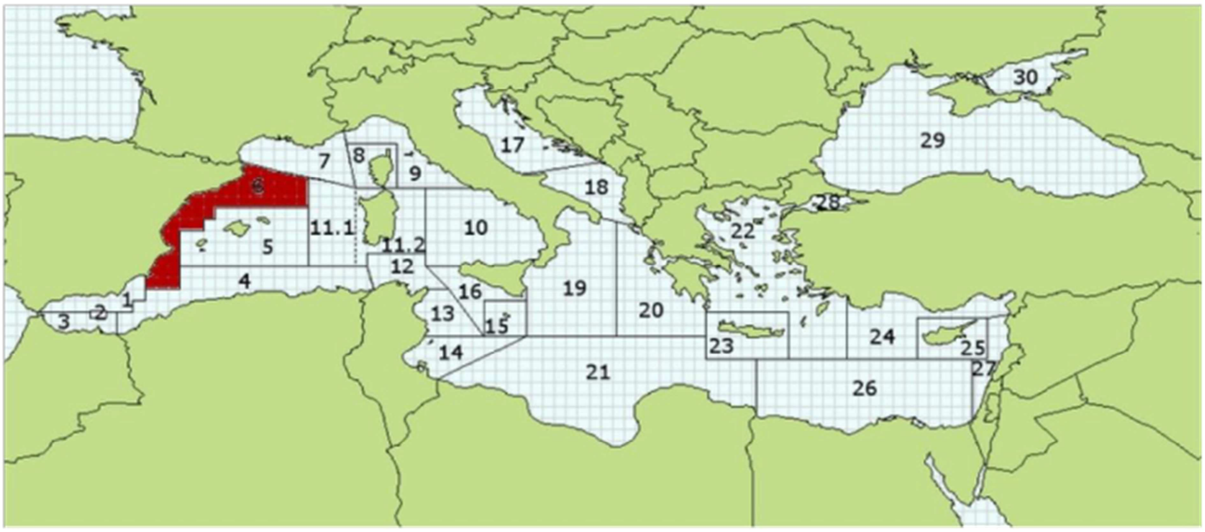


Fig. 4.2.1.1. Geographical location of GSA 6.

4.2.1.2 Growth

EWG 14-09 notes that no growth parameters were available from the DCF. The growth parameters used in the present assessment correspond to the fast growth hypothesis: L_{inf}= 106.0; k = 0.20, t0= -0.0028 (Garcia Rodriguez & Esteban, 2002). The length-weight relationship parameters are a=0.0048 and b=3.12, also taken from Garcia Rodriguez & Esteban (2002). These parameters are the same used in the previous assessment of this stock (STECF EWG 11-12).

4.2.1.3 Maturity

The maturity ogive was taken from taken from the STECF EWG 11-12 report. The maturity ogive was obtained through DCF official data for the period 2002- 2004, with size at first maturity (50 %, both sexes combined) at 32 cm TL. The maturity status was determined by macroscopic examination of the gonads during the reproductive period (no indication was provided on the months when the sampling of the gonads was conducted).

Maturity ogive

age	0	1	2	3	4	5+
maturity	0	0.14	0.82	0.98	1	1

4.2.1.4 Fisheries

4.2.1.4.1 General description of the fisheries

Hake is one of the most important target species for the trawl fisheries in GSA 6. It is also caught by longliners, and gill and trammel netters. The annual landings of this species, which are mainly composed by juveniles living on the continental shelf, fluctuated around 3100 tonnes since 2005. Landings by fishing gears other than bottom trawl represented less than 10% of the annual total catches over 2002- 2013, except 2006-2007 (around 15%). The trawl fleet in GSA 6 has been decreasing over the last 10 years, from around 670 vessels in 2004-2005 to 540 in 2012 (see tables 4.2.1.4.5.1 and 4.2.1.4.5.2).

4.2.1.4.2 Management regulations applicable in 2013

Trawl fisheries in GSA 6 are regulated by "Orden AAA/2808/2012" published in the Spanish Official Bulletin (BOE nº 313 29 December 2012) containing an Integral Management Plan for Mediterranean fishery resources. To the traditional fisheries regulations already in place (e.g. the daily and weekly fishing effort limited to 12 hours per day five days a week; trawl cod end 40 mm square mesh or 50 mm diamond stretched mesh; engine power of maximum 373 kW; license system; minimum landing size of 20 cm TL), this plan adds that fishing mortality for hake in GSA 6 should be kept at or below the reference value F_{MSY} = 0.15 and that fishing effort be reduced by 20% or more over the period 2013-2017 (based on the effort established on 1 January 2013). This fishing effort reduction will be measured in terms of number of vessels, engine power and tonnage.

4.2.1.4.3 Catches

4.2.1.4.4 Landings

DCF annual landings (t) in GSA 6 in the period 2002-2013, by fishing gear, are shown in Table 4.2.1.4.4.1 and Fig. 4.2.1.4.4.1 and the corresponding annual size distributions by gear are presented in 4.2.1.4.4.2 (LLS size data available for the period 2009-2013; no data on GTR sizes submitted).

Table 4.2.1.4.4.1. Hake in GSA 6. Landings (t) by fishing gear during 2002-2013.

	OTB(t)	**LLS (t)**	**GNS(t)**	**GTR(t)**
2002	2566,3	184,2	84,3	
2003	4349,6	123,9	159,2	
2004	4836,2	204,2	350,1	
2005	2715,0	134,6	179,0	
2006	2961,3	244,7	231,9	
2007	2275,4	229,1	187,1	
2008	2993,2	122,8	117,5	
2009	3548,0	95,4	180,9	22,9
2010	2601,0	206,1	8,1	6,4
2011	2875,5	174,9	91,7	39,5
2012	2470,6	97,6	45,5	27,6
2013	2688,3	187,9	27,5	46,2

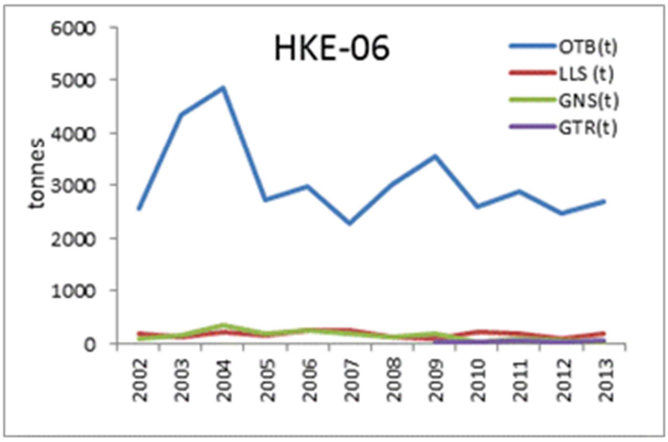


Fig. 4.2.1.4.4.1. Hake in GSA 6. Landings (t) by fishing gear over 2002-2013.

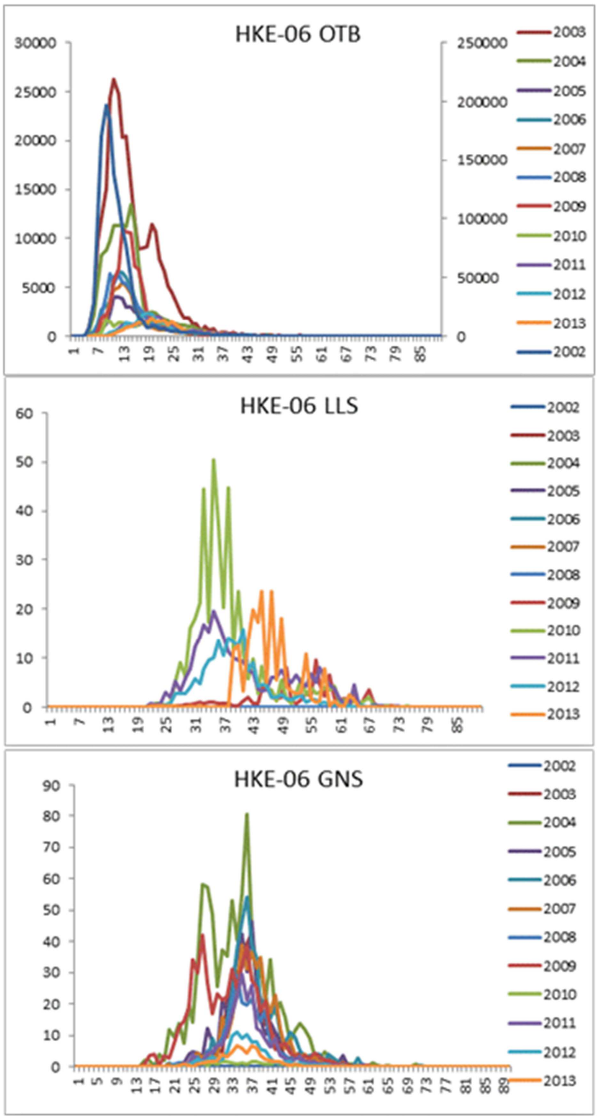


Fig. 4.2.1.4.4.2. Hake in GSA 6. DCF Annual sizes distributions of landings by fishing gear during 2002-2013 (for OTB in 2002, the values are shown on the right axis).

Discards

Reported OTB discards of hake in GSA 6 were 141.6 t in 2011, 194.3 in 2012 and 156.6 t in 2013. These amounts represented 4.7%, 7.3% and 5.5% respectively of the OTB annual catch. Reported LLS discards were 3.7 t in 2011 and 12.6 t in 2013, which represented 2.1% and 6.3% of the LLS annual catch. No information was available on the discards distributions of sizes.

4.2.1.4.5 Fishing effort

Fishing effort data submitted to EWG 14-09 should be checked for consistency as the values were different compared to these previously submitted (see 4.2.1.8 data quality section). Hake landings area mainly from OTB. Tables 4.2.1.4.5.1 and 4.2.1.4.5.2 show the OTB number of vessels trend in the period 2002-2010 and 2009-2012.

Table 4.2.1.4.5.1. Number of OTB vessels in GSA 6 in the period 2002- 2010 (taken from EWG 12-10 report, page 122).

Num.ves.	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
VL0012	30	28	30	28	28	26	27	22	21
VL1224	468	507	521	523	493	474	477	429	421
VL2440	106	114	122	125	127	134	135	129	125
ALL	604	649	673	676	648	634	639	580	567

Table 4.2.1.4.5.2. Number of OTB vessels, nominal fishing effort and capacity in GSA 6 in 2009-2012 (taken from EWG 13-19 report, page 109).

Year	**2009**	**2010**	**2011**	**2012**
Vessels	558	546	540	540
Nominal effort kW x days at sea (000s)	17940	16525	15417	14574
GT x days at sea (000s)	3771	3511	3254	3087

4.2.1.5 Scientific surveys

MEDITS

4.2.1.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 6 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002). In GSA 6 the following number of hauls with hake catch was reported per depth stratum in the DCF 2013 data call:

Table 4.2.5.1.1. MEDITS. Number of hauls per depth stratum with hake catch in GSA 6, 1994- 2013.

depth stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
010-050	5	5	5	4	5	7	7	5	8	7
050-100	19	23	26	23	27	26	28	29	34	36
100-200	10	16	14	14	12	16	17	18	19	20
200-500	5	8	6	8	4	5	4	9	10	11
500-800	0	2	2	0	0	0	1	1	0	1
total	39	54	53	49	48	54	57	62	71	75
depth stratum	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
010-050	7	10	9	5	5	5	3	4	7	10
050-100	30	30	30	26	28	28	19	28	33	38
100-200	16	17	16	14	21	20	11	19	22	24
200-500	8	7	15	5	8	7	8	7	12	11
500-800	1	1	2	2	1	2	1	2	3	0
total	62	65	72	52	63	62	42	60	77	83

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai2 * si\ 2 / ni) / A2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

4.2.1.5.2 Geographical distribution

No specific analyses were conducted during EWG 14-09.

4.2.1.5.3 Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 1994-2013 was used to derive indices of abundance and biomass for hake in GSA 6 (Fig. 4.2.5.3.1). Both abundance and biomass have fluctuated in the area during this period. Abundance did not display a clear trend, but biomass increased over 1994- 2006, and decreased markedly in 2007. The highest abundance and biomass were observed in 2006. In the most recent years 2011-2013 abundance is low while biomass is not at its lowest values, suggesting low abundance of small individuals.

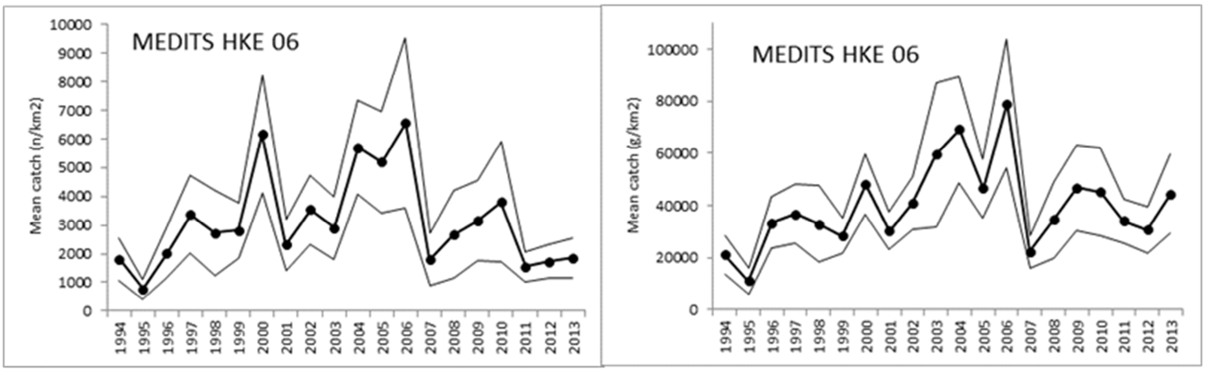


Fig. 4.2.5.3.1. Hake in GSA 6. Abundance (left) and biomass (right) indices from MEDITS surveys (mean and 95% confidence intervals).

4.2.1.5.4 Trends in abundance by length or age

Figure 4.2.5.4.1 shows the standardized distributions of sizes of hake from MEDITS surveys in GSA 6 in the period 1994- 2013. Most individuals are less than 19 cm TL, which according to the growth parameters used in this assessment correspond to age class 0. Lowest abundances were observed in the period 2011-2013.

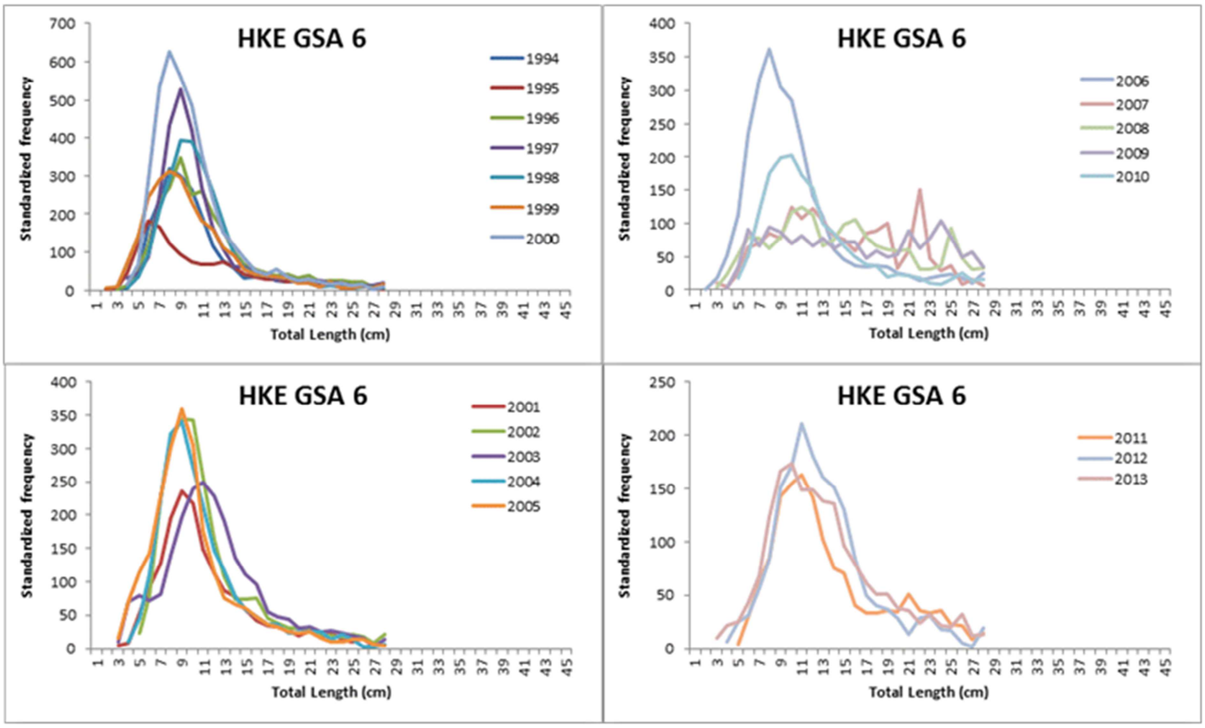


Fig. 4.2.5.4.1. Hake in GSA 6. Standardized size frequencies distributions from MEDITS surveys 1994-2013.

4.2.1.5.5 Trends in growth

No specific anaylses were carried out during EWG 14-09.

4.2.1.5.6 Trends in maturity

No specific anaylses were carried out during EWG 14-09.

4.2.1.6 Assessment of historic stock parameters

4.2.1.6.1 Methods

Method 1 : XSA

4.2.1.6.2 Justification

Stock assessment using XSA was performed, calibrated with fishery independent survey abundance indices (MEDITS) for the period 2002-2013.

4.2.1.6.3 Input parameters

Input data were taken from DCF. The growth parameters used in the present assessment correspond to fast growth: L_{inf}= 106.0; k = 0.20, t0= -0.0028 (Garcia Rodriguez & Esteban, 2002). Numbers by age were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software. The tuning parameters (MEDITS) were calculated by transforming the standardized MEDITS length distributions to ages using L2Age4.

Table 4.2.1.6.3.1 lists the input parameters to the XSA, namely catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) were computed using PROBIOM.

Table 4.2.1.6.3.1. Hake in GSA 6. Input parameters to the XSA model.

Catch at age (thousands)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	132523.73	79443.93	116905.5	29482.3	50719.7	38423.0	51252.6	72083.2	13254.0	9275.2	11079.0	7713.9
1	7511.06	25569.61	21009.4	9600.0	11665.8	7018.4	10373.3	11742.1	13533.2	15907.1	13031.7	14681.4
2	947.65	1201.79	1555.2	989.5	1408.6	1412.9	731.9	1562.1	1907.3	1851.5	1126.6	1159.9
3	109.99	134.96	166.2	143.3	185.7	202.2	88.7	257.9	162.9	177.2	86.0	138.2
4	0.72	25.34	13.9	14.2	12.0	25.8	10.8	24.6	49.8	28.7	18.8	11.4
5+	0.00	5.55	13.7	.0	4.3	7.5	1.1	4.6	2.7	4.4	1.4	.3

Weight at age

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
1	0.12	0.10	0.12	0.12	0.12	0.13	0.12	0.10	0.12	0.12	0.11	0.12
2	0.48	0.47	0.48	0.48	0.48	0.47	0.45	0.49	0.46	0.47	0.47	0.47
3	1.11	1.15	1.03	1.07	1.03	1.10	1.17	1.20	1.12	1.09	1.07	1.08
4	1.57	1.84	1.89	1.88	1.84	1.90	1.77	1.90	1.85	1.88	1.75	1.94
5+	3.45	2.78	2.90	3.45	5.62	3.64	2.80	3.53	2.80	2.78	2.68	4.97

Maturity and mortality vectors

age	0	1	2	3	4	5+
maturity	0	0.14	0.82	0.98	1	1
M	1.12	0.55	0.44	0.39	0.36	0.35

Tuning parameters (MEDITS)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	2178.2	2019.2	2069.0	2157.0	2382.8	1216.6	1243.0	1003.5	1470.5	1152.5	1545.5	1508.2
1	220.3	225.5	161.4	150.0	213.9	471.0	473.8	647.0	169.6	290.5	200.3	274.5
2	14.0	15.1	13.4	11.2	6.5	5.5	.0	37.3	.0	10.1	.9	5.2

The number of individuals by age in 2002 and 2003 was SOP corrected [SOP = Landings / Σ*a* (total catch numbers at age *a* x catch weight-at-age *a*)] before running the analysis.

Different sensitivity analyses were performed before running the final XSA, considering different weight and ages for shrinkage.

For the final run, the following settings were used:

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1,5	-1	3	TRUE	TRUE	3	3

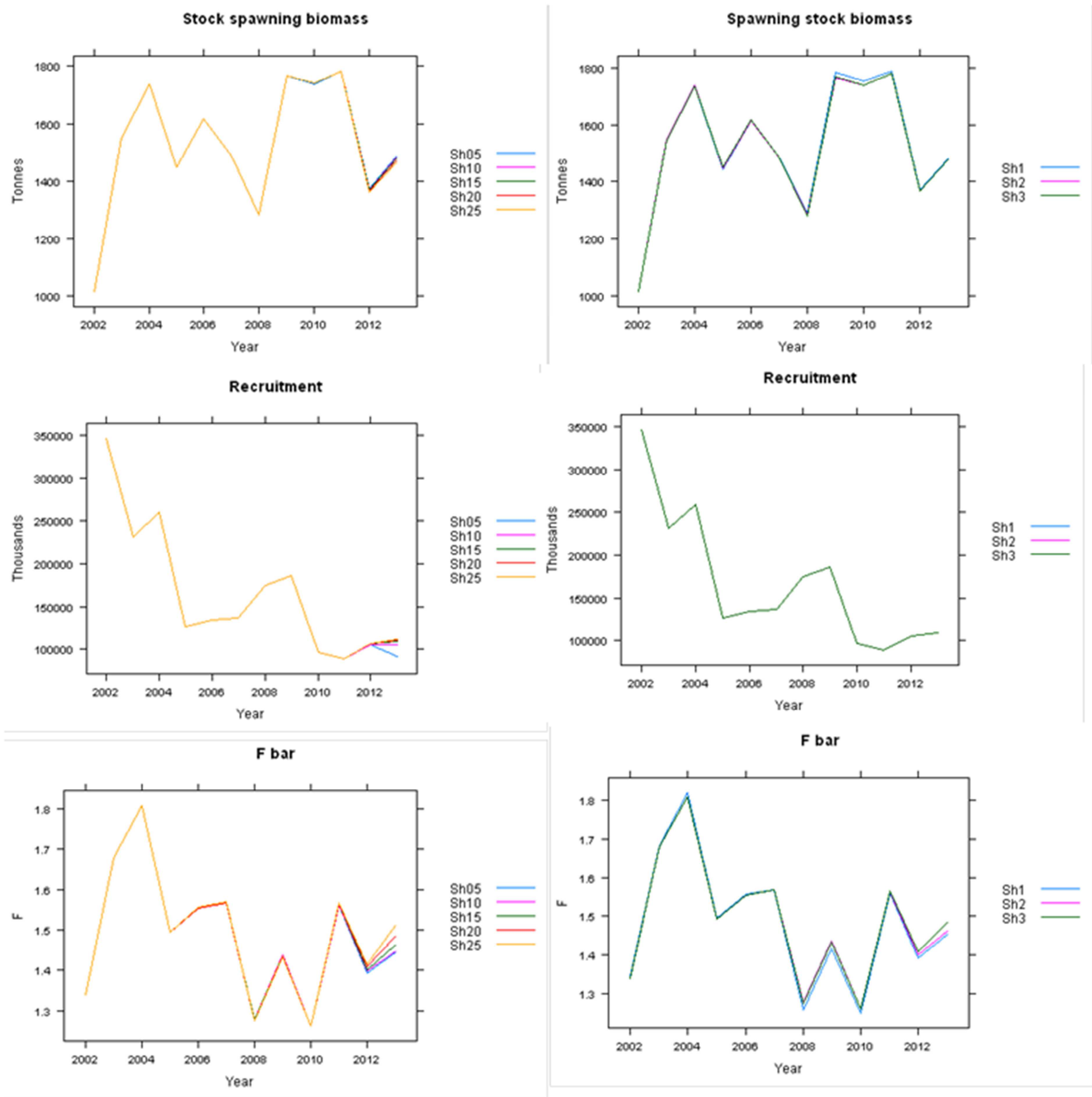


Fig. 4.2.1.6.3.1. Hake in GSA 6. Sensitivity analysis considering different weight and ages for shrinkage.

4.2.1.6.4 Results

XSA results are presented in Figs.4.2.1.6.4.1, 4.2.1.6.4.2 and 4.2.1.6.4.3 and Tables 4.2.1.6.4.1 and 4.2.1.6.4.2.

The exploitation of hake in GSA 6 is based on the younger classes. It is worth noting that in the period 2002-2013 recruitment decreased from 346 millions to around 110 millions. In 2010- 2012 recruitment values are the lowest of the whole period.

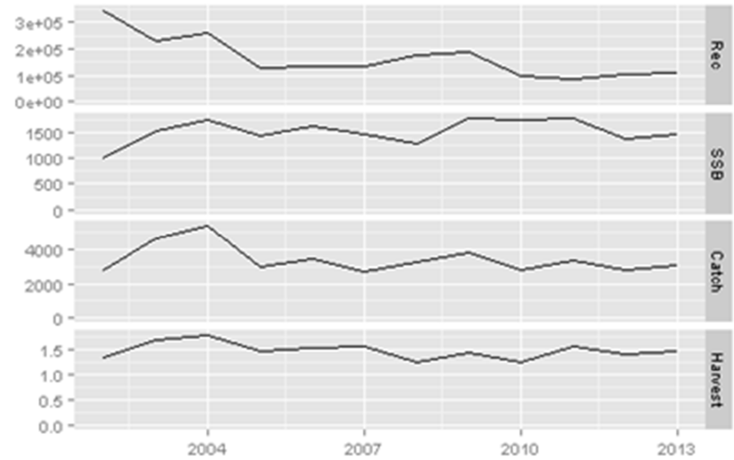


Fig. 4.2.1.6.4.1. Hake in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

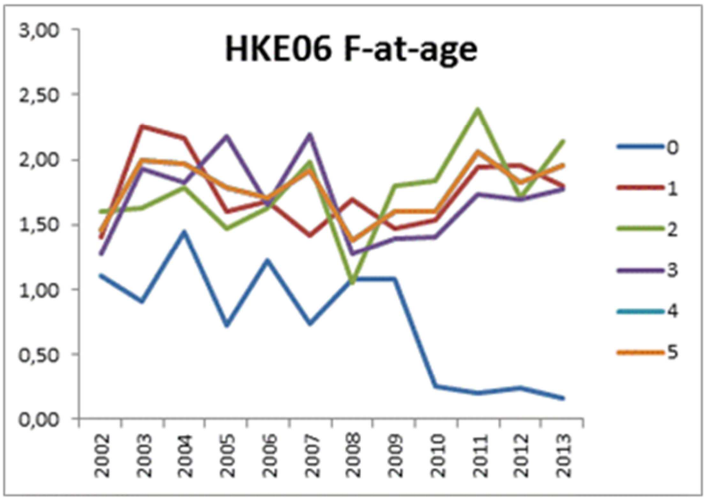


Fig. 4.2.1.6.4.2. Hake in GSA 6. XSA results. Fishing mortality at age.

Table 4.2.1.6.4.1. Hake in GSA 6. XSA summary results.

	Population in number (thousands)	Population in weight (tons)	Recruitment number (thousands)	SSB (tons)	$F_{0\text{-}3}$
2002	361044.8	6006.8	346260.0	1013.2	1.35
2003	271350.1	8680.4	231640.0	1545.8	1.68
2004	292644.7	9546.2	259670.0	1737.2	1.81
2005	148424.2	6153.9	126210.0	1450.0	1,49
2006	156724.2	6311.7	133930.0	1616.6	1.55
2007	151860.0	5539.9	136460.0	1486.0	1.58
2008	197968.5	6519.7	174500.0	1279.9	1.27
2009	208613.0	7830.0	186320.0	1769.5	1.43
2010	120493.1	6067.1	96740.0	1741.0	1.26
2011	116363.7	7022.8	88758.0	1782.6	1.57
2012	132206.8	6914.3	106270.0	1366.9	1.40
2013	139369.0	7751.6	109880.0	1476.4	1.47

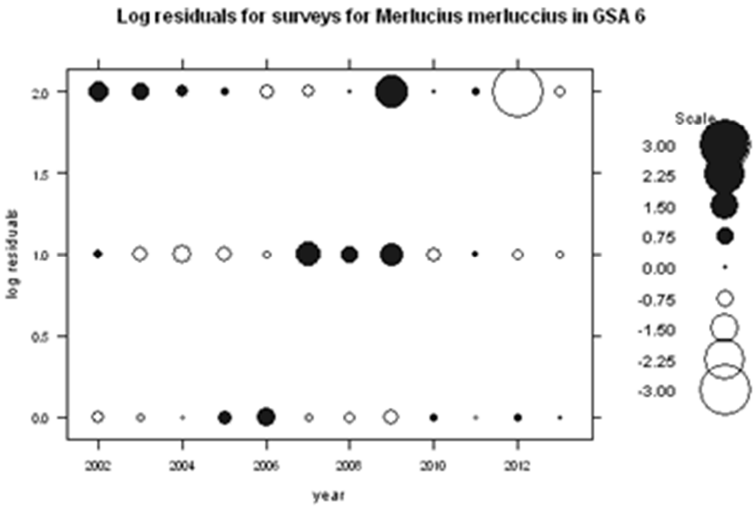


Fig. 4.2.1.6.4.3. Hake in GSA 6. Log catchability residuals of the tuning data used from the MEDITS surveys.

Table 4.2.1.6.4.2. Hake in GSA 6. Log catchability residuals of the tuning data used from the MEDITS surveys.

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	-0.380	-0.127	-0.011	0.471	0.705	-0.174	-0.268	-0.547	0.172	-0.002	0.126	0.035
1	0.202	-0.500	-0.658	-0.526	-0.149	0.985	0.588	0.905	-0.469	0.053	-0.272	-0.159
2	0.753	0.610	0.349	0.172	-0.456	-0.414	0.000	1.381	0.000	0.176	-2.272	-0.299
2	0.753	0.610	0.349	0.172	-0.456	-0.414	0.000	1.381	0.000	0.176	-2.272	-0.299

Retrospective analysis showed a quite robust results for SSB, F and R (Fig. 4.2.1.6.4.4).

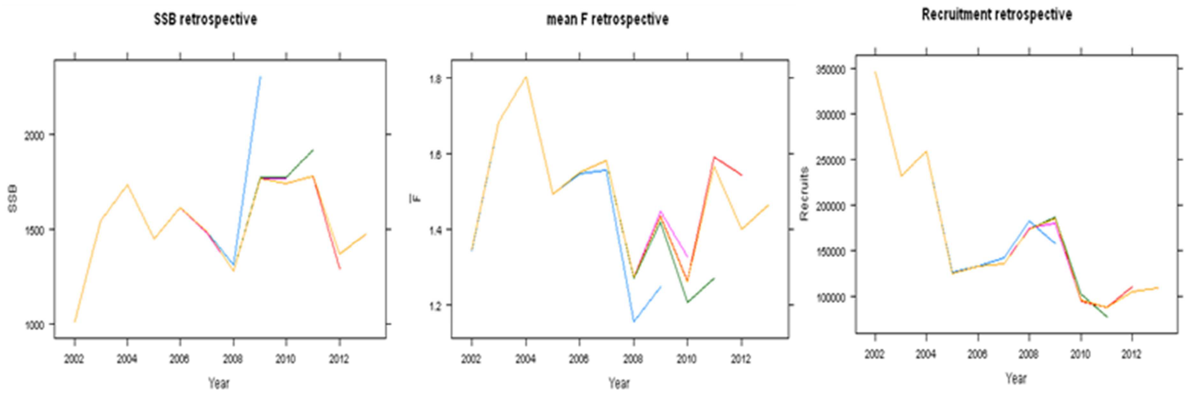


Fig. 4.2.1.6.4.4. Hake in GSA 6. Retrospective analysis for SSB, F and R.

4.2.1.7 Long term prediction

4.2.1.7.1 Justification

Method 2: Yield per Recruit

Yield per Recruit (Y/R) analysis was run to estimate the exploitation reference point $F_{0.1}$ (as a proxy of F_{MSY}) using using the R script provided to the EWG by JRC.

4.2.1.7.2 Results

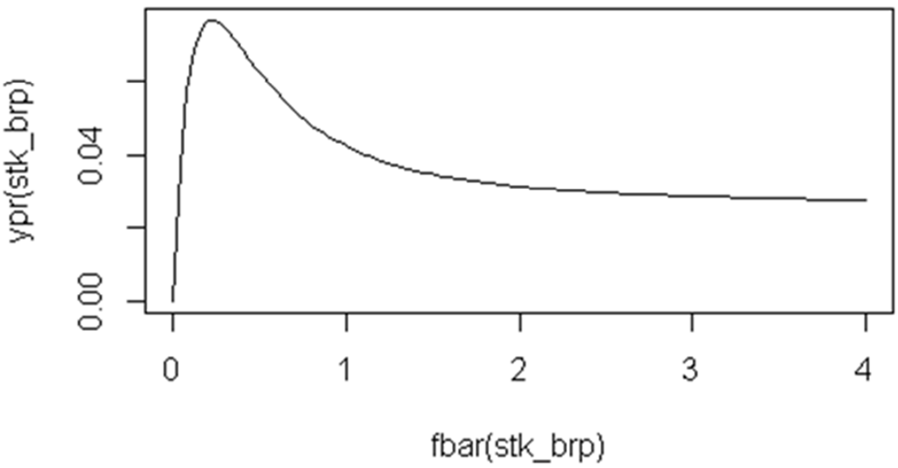


Fig. 4.2.7.2.1. Hake in GSA 6. Yield per recruit.

Table. 4.2.7.2.1. Hake in GSA 6. Current F and reference point.

FMSY= 0.15			
Fcurr = 1.48	F0-3 in the last 3 years		

It is worth mentioning that F_{MSY}= 0.15 is the same value as the reference value F_{MSY} = 0.15 estimatyed for hake in GSA 6 in 4.2.1.4.2 ”Management regulations applicable in 2013”.

4.2.1.8 Data quality

Biological parameters

At present, there is no obligation for the MS to submit the biological parameters used for transforming the annual size distributions into ages. It would be advisable to request this information in future data calls, since biological parameters are used in the assessments.

Fishing effort data

Fishing effort data should be checked. Values provided to EWG 14-09 were much higher than those submitted in previous meetings. As an example, see in Table 4.2.1.8.1 the number of OTB vessels. When checked against the values reported by the autonomous governments of Catalonia, Valencia and Murcia (the zones included in GSA 6), the total number of vessels from these regions are similar to those reported in previous EWGs. For this reason, fishing effort data in the present report have been taken from the EWG 13-19 and EWG 12-10 reports, that included OTB fishing effort trend in the period 2002-2010 and 2009-2012

Table 4.2.1.8.1. Number of OTB vessels by vessel length in GSA 6 in the period 2009- 2013 according to the DCF. For comparison, the number of vessels in the EWG 13- 19 report is given in the right column (VL1224+VL2440).

	VL0612	VL1218	VL1224	VL1824	VL2440	**EWG 14-09**	**EWG-13-19 (VL1224+VL2440)**
2009	21	141		451	230	**843**	**558**
2010	27		582		218	**827**	**546**
2011	27	136		393	200	**756**	**540**
2012	19	132		367	211	**729**	**540**
2013	19	127		362	205	**713**	

Numbers at age

Values in 2002 and 2003 were SOP corrected before running the assessment. Thus, the numbers and weight at age in the landings (and the annual distributions by size) should be checked for consistency.

MEDITS

MEDITS data for hake in GSA 6 used in the present assessment were made available by experts participants to EWG 14-09, because MEDITS data were not provided to the EWG in the standardised and final format, which made the task of producing the survey index for the assessment data rather difficult and time consuming for those experts not familiar with the MEDITS database.

4.2.1.9 Scientific advice

4.2.1.10 Short term considerations

4.2.1.10.1 State of the stock size

No clear trend was identified for SSB, with oscillations around 1500 t in the period 2002-2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.1.10.2 State of recruitment

In the period 2002-2013 recruitment decreased from 346 to around 110 millions. In 2010- 2012 recruitment values are the lowest of the whole period.

4.2.1.10.3 State of exploitation

The current F (1.48) is larger than F_{MSY} (0.15), which indicates that hake in GSA 6 is exploited unsustainably.

4.2.1.11 Management recommendations

EWG 14-09 advise the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considered.

4.2.2 STOCK ASSESSMENT OF RED MULLET IN GSA 6

4.2.2.1 Stock Identification

Due to the lack of information about the structure of red mullet (*Mullus barbatus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries. (Figure 4.2.2.1.1).

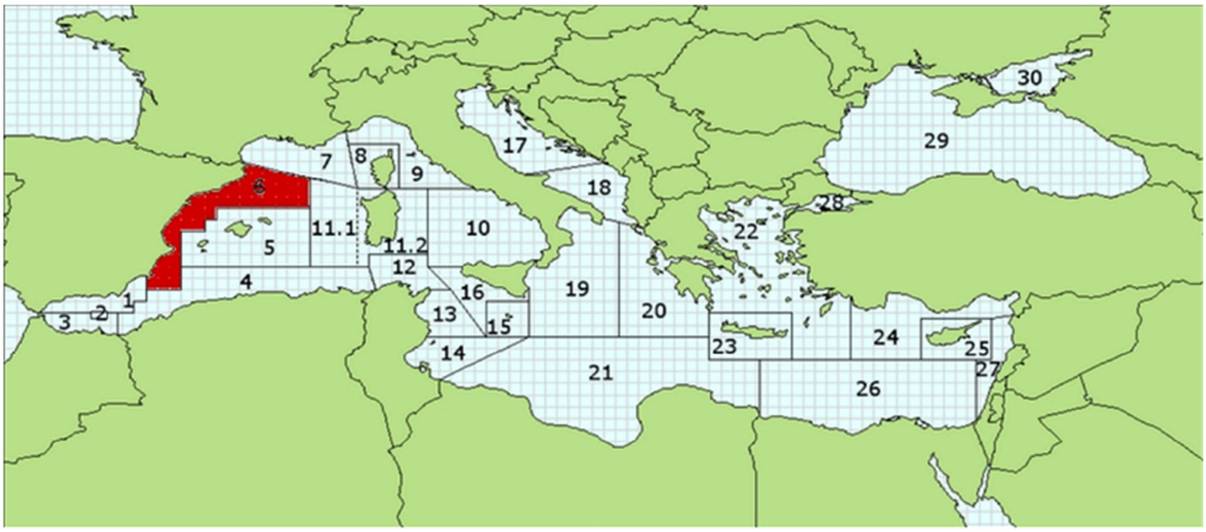


Figure 4.2.2.1.1. Geographical location of GSA 6.

4.2.2.2 Growth

Growth parameters used were those already used in the previous assessment of this stock (STECF EWG 13-19). They correspond to a "fast growth" hypothesis and are in line with the growth parameters used in other areas. The values of the von Bertalanffy growth function parameters were L_{inf} = 29.0 cm, k= 0.60, t_0=-0.10 (from GSA 9). The length-weight relationship parameters are from the study area: a=0.00624 and b=3.1597 (Fernández, 2010).

4.2.2.3 Maturity

Maturity ogive was the same used in the last assessment of this stock (STECF 13-19), with a size at first maturity at 12.2 cm TL

Age class	**0**	**1**	**2**	**3**	**4+**
Maturity ratio	0.46	0.76	0.88	0.93	1

4.2.2.4 Fisheries

4.2.2.4.1 General description of Fisheries

Red mullet is caught in GSA 6 mainly by bottom trawlers fishing on the continental shelf, between 50 and 200 m depth. It is also caught by trammel nets, but in a lower proportion, representing in general less than 10% of total catches.

The percentage of caught individuals under the minimum legal size (11 cm TL) has clearly decreased during the period considered, from very high values in 2002 (more than 60%) to values lower than 2% for the last two years (Figure 4.2.2.4.1.1). This decreased could be associated to the Council Regulation (EC) No 1967/2006 coming into force on 1st June 2010, in which a change in the mesh shape from 40 mm diamond to 40 mm square was established. According to selectivity studies carried out in the study area, length at first catch (L50) for *M. barbatus* in GSA 6 increases from 7.8 cm with 40 mm diamond mesh to 13.7 cm with 40 mm square mesh.

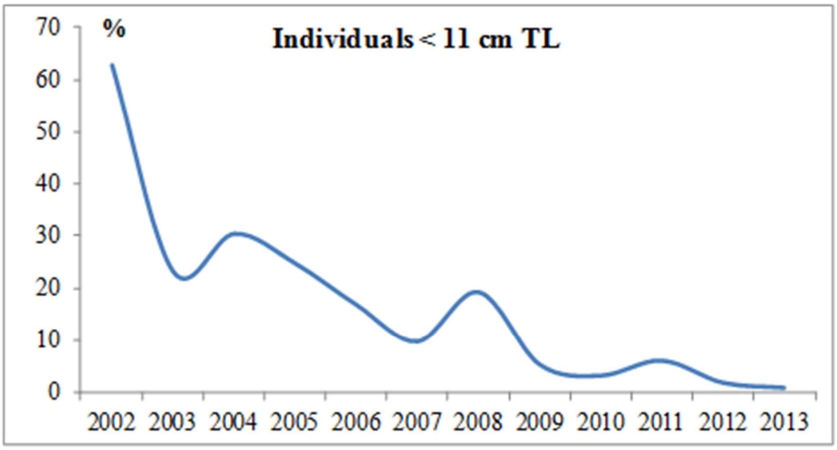


Figure 4.2.2.4.1.1. Red mullet in GSA 6. Percentage of caught individuals under the minimum landing size (11 cm TL).

4.2.2.4.2 Management regulations applicable in 2014

Trawl fisheries in GSA 6 are regulated by "Orden AAA/2808/2012" published in the Spanish Official Bulletin (BOE nº 313 29 December 2012) containing an Integral Management Plan for Mediterranean fishery resources. To the traditional fisheries regulations already in place (e.g. the daily and weekly fishing effort limited to 12 hours per day five days a week; trawl cod end 40 mm square mesh or 50 mm diamond stretched mesh; engine power of maximum 373 kW; license system; minimum landing size of 11 cm TL), this plan adds that fishing mortality for Mullus barbatus in GSA 6 should be kept at or below the reference value F_{MSY} = 0.17, and that fishing effort be reduced by 20% or more over the period 2013-2017 (based on the effort established on 1 January 2013). This fishing effort reduction will be measured in terms of number of vessels, engine power and tonnage.

4.2.2.4.3 Catches

OTB data on discards are available for 2005 and for 2008-2013. Discards represent lower than 2.5% of the OTB catches in weight. GTR data on discards are available for 2007 and 2009, with values lower than 1%. Discards were assumed to be negligible in the present stock assessment.

4.2.2.4.4 Landings

OTB landings of red mullet in GSA 6 oscillated between a minimum value in 2002 (300 t) and a maximum (1700 t) in 2004, with an increasing trend during the last years (from 2010). GTR landings were always lower than 150 t (Figure 4.2.2.4.4.1).

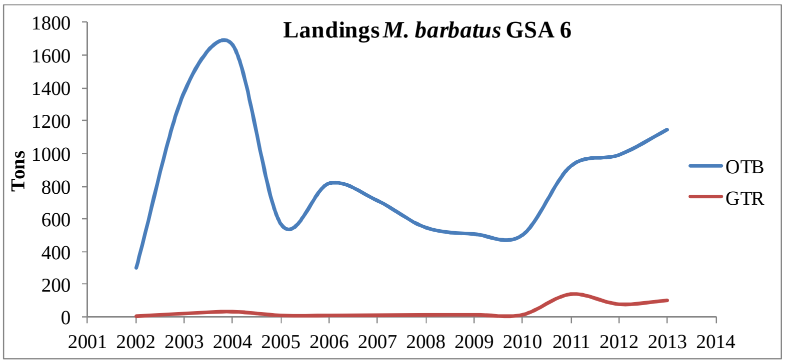


Figure 4.2.2.4.4.1. Red mullet in GSA 6. Landings by gear and year.

The size frequency of the landings (average 2002-2013 for OTB and 2009-2013 for GTR) is shown in Figure 4.2.2.4.4.2. Both gears showed a mode at 15-16 cm, but the importance of individuals under 14 cm is higher for OTB.

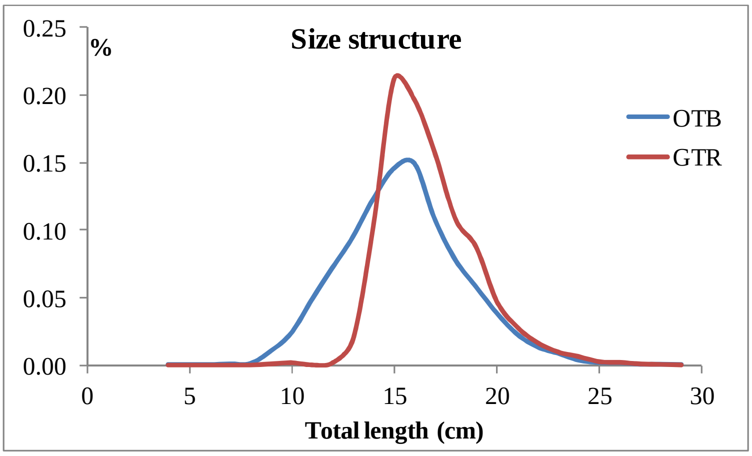


Figure 4.2.2.4.4.2. Red mullet in GSA 6. Frequency distribution (in proportion) of the sampled commercial landings by gear.

4.2.2.4.5 Fishing Effort

Data available for fishing effort covers the period 2009-2013. Both nominal effort and GT·days at se for OTB showed a clear decreasing trend for the period considered. In the case of GTR, this variable showed certain stability for all the period. The variable number of boats should be considered by fishery as if we grouped, we could be overestimating the values, as a single boat can (and usually does) operate in the different OTB fisheries. The values are quite constant for the last year, and the same happens with the number of boats in GTR. (Figure 4.2.2.4.5.1).

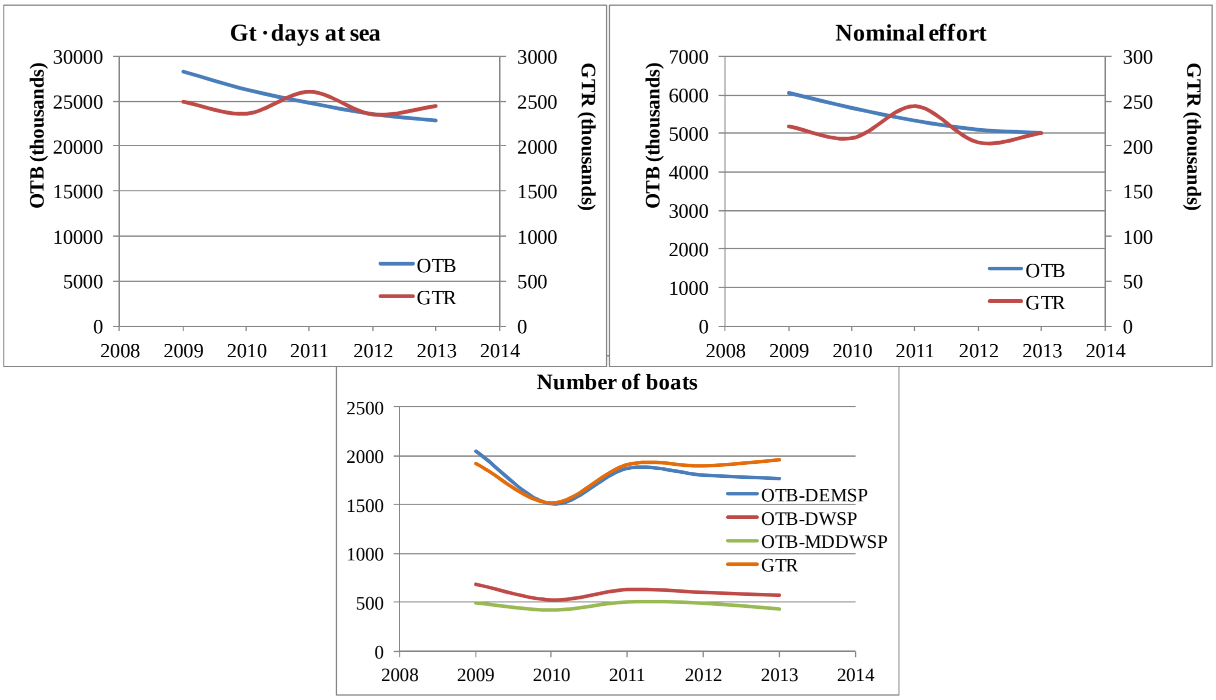


Figure 4.2.2.4.5.1. Red mullet in GSA 6. Fishing effort by gear or metier.

4.2.2.5 Scientific surveys

4.2.2.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 6 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002).

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). The abundance and biomass indices were calculated through stratified means (Cochran, 1953; Saville, 1977) using the following formula:

$$Y_{st} = \Sigma\ (Y_i * A_i)\ /\ A$$
$$V(Y_{st}) = \Sigma\ (A_i^2 * s_i^2\ /\ n_i)\ /\ A^2$$

Where:

- A=total survey area
- A_i=area of the i-th stratum
- s_i=standard deviation of the i-th stratum
- n_i=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Y_i=mean of the i-th stratum
- Y_{st}=stratified mean abundance
- $V(Y_{st})$=variance of the stratified mean

The variation of the stratified mean is then expressed as the standard deviation. Length distributions were standardized through stratified means, following the same methodology applied for abundance and biomass.

4.2.2.5.2 Geographical distribution

No specific analyses were conducted during EWG 14-09.

4.2.2.5.3 Trends in abundance and biomass

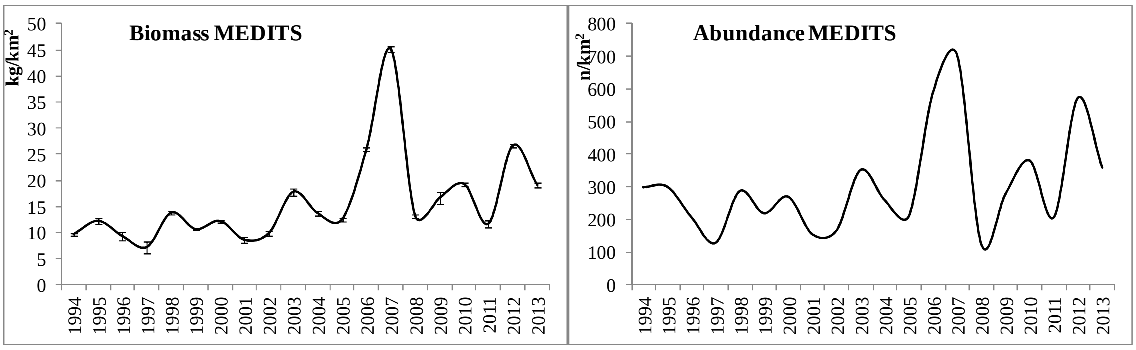


Figure 4.2.2.5.3.1. Red mullet in GSA 6. Standardized biomass and abundance from the MEDITS surveys.

4.2.2.5.4 Trends in abundance by length or age

Figure 4.2.2.5.4.1 shows the standardized size frequencies of red mullet in GSA 6 in the period 2002-2013 from MEDITS. Most individuals are between 10 and 20 cm TL, although individuals below 10 cm are abundant for some years (i.e. 2006).

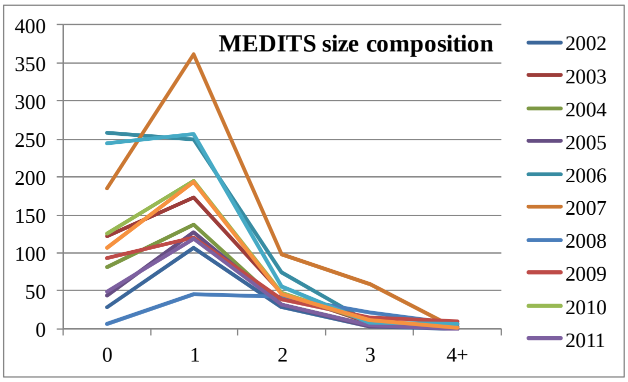


Figure 4.2.2.5.4.1. Red mullet in GSA 6. Standardized size frequencies from the MEDITS survey.

4.2.2.5.5 Trends in growth

No specific analyses were carried out during EWG 14-09.

4.2.2.5.6 Trends in maturity

No specific analyses were carried out during EWG 14-09.

4.2.2.6 Assessment of historic stock parameters

4.2.2.6.1 Methods

The assessment has been performed with an Extended Survivor Analysis (XSA) using de FLR library in R, with the MEDITS survey abundance and biomass indices as tuning fleet, for the period 2002-2013. This assessment is an update of the one performed in 2013 (STECF EWG 13 19).

4.2.2.6.2 Input parameters

The data used in the assessment were: (i) Landings time series 2002-2012 from OTB and GTR (GTR data 2002-2008 reconstructed from 2009-2013 average); (ii) Age distributions obtained from slicing of length distributions 2000-2012; (iii) Set of growth parameters adopted in the SGMED-08-03 meeting (slow growth parameters from otolith reading) and (iv) BALAR-MEDITS survey used as tuning fleet (abundances by age in n/km^2).

The growth parameters used for VBGF were L_{inf}= 29.0 cm; k = 0.60 yr^{-1}; t_0= -0.10 yr (based on the fast growth hypothesis, from GSA 9). The length-weight coefficients used were those recently estimated by the Spanish Data Collection Programme for the years 2011-2012: a= 0.006240, b= 3.15970.

Numbers at age for the commercial fleet and the survey were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software.

Table 4.2.2.6.2.1 lists the input parameters to the XSA, namely catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS), corresponding to ages 1-3 only because age 0 is not well represented in the MEDITS surveys. Natural mortality values (vector) were computed using PROBIOM. M for age group 0 is the mean over the first 12 months.

Table 4.2.2.6.2.1. Red mullet in GSA 6. Input parameters to the XSA.

Catch at age

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	17678.4	27343.7	44396.7	13322.1	18030.5	12216.7	9497.4	5762.9	2153.6	7967.4	4783.5	5352
1	4240.5	22619.9	28181	9431.9	14517.3	13451.9	10456.2	7609.4	7995.8	19362.7	18467.1	22694.5
2	146.1	938.6	499.5	314.9	268.8	128	368.6	841.8	1065.3	1262.8	1314.2	1402.7
3	11.5	67.9	24	17.5	14.4	10.7	13.1	28	30.4	121.1	121.6	146.4
4+	0.4	8.4	1.7	2.7	3.1	3.1	1	3.9	37	23.8	57.3	29.4

Weight at age

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.009	0.014	0.013	0.014	0.016	0.017	0.013	0.018	0.018	0.017	0.018	0.019
1	0.041	0.047	0.045	0.045	0.042	0.043	0.043	0.049	0.049	0.045	0.049	0.048
2	0.11	0.108	0.105	0.107	0.105	0.108	0.107	0.107	0.111	0.11	0.107	0.109
3	0.161	0.162	0.161	0.17	0.166	0.167	0.163	0.168	0.159	0.162	0.176	0.168
4+	0.2	0.198	0.211	0.215	0.211	0.217	0.205	0.215	0.237	0.219	0.199	0.208

Maturity and natural mortality

Age class	0	1	2	3	4+
Maturity	0.46	0.76	0.88	0.93	1
M	0.99	0.46	0.3	0.24	0.21

Tuning parameters (MEDITS)

	Age 0	Age 1	Age 2	Age 3
2002	28.011	122.436	81.676	44.306
2003	106.395	173.095	137.155	127.410
2004	28.077	47.086	32.189	32.099
2005	3.157	7.529	5.630	3.535
2006	0.000	1.659	1.952	3.370
2007	28.011	122.436	81.676	44.306
2008	106.395	173.095	137.155	127.410
2009	28.077	47.086	32.189	32.099
2010	3.157	7.529	5.630	3.535
2011	0.000	1.659	1.952	3.370
2012	28.011	122.436	81.676	44.306

4.2.2.6.3 Results

Both recruitment and SSB showed an increasing trend for the last 5 years, reaching values similar to the maximum values found at the beginning of the data series (Figure 4.2.2.6.3.1).

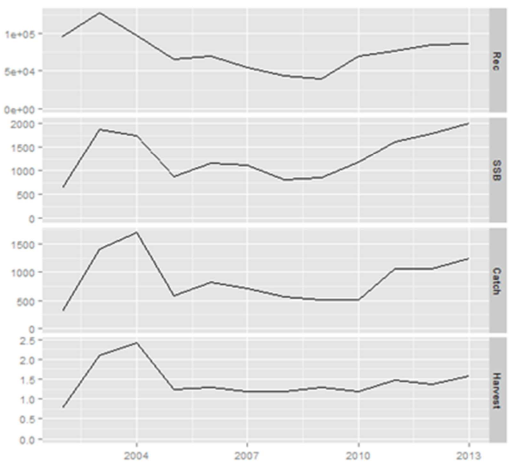


Figure 4.2.2.6.3.1. Red mullet in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Table 4.2.2.6.3.1. Red mullet in GSA 6. XSA summary results.

	Population in number (thousands)	Population in weight (tons)	Recruitment number (thousands)	SSB	$F_{0\text{-}2}$
2002	103104	1165.9	96444	630.65	0.77
2003	154740	3158	127096	1883.72	2.09
2004	130337	2789.9	97429	1749.5	2.41
2005	77990	1516.5	65384	885.13	1.25
2006	87926	1953.8	69780	1165.62	1.28
2007	71954	1797.5	54619	1116.68	1.18
2008	57764	1261.2	43264	806.28	1.19
2009	51958	1389.7	39934	859.22	1.28
2010	82965	2021.5	69760	1187.66	1.18
2011	102565	2605.2	76134	1617.3	1.46
2012	111361	2932	85566	1795.94	1.38
2013	117316	3256.4	86341	2011.61	1.58

Residuals from the MEDITS tuning fleet show low values for all the ages and years considered. After some trials, in the last run ages 0-3 were considered (Figure 4.2.2.6.3.2).

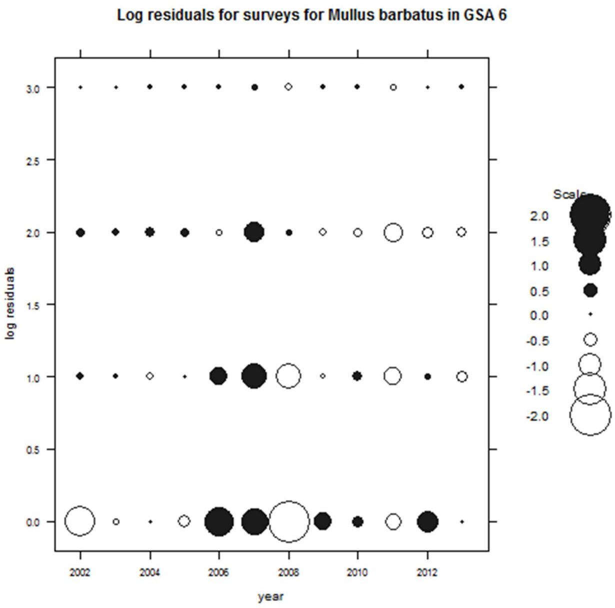


Figure 4.2.2.6.3.2. Red mullet in GSA 6. Log catchability residuals plots (XSA) for MEDITS survey.

Retrospective analysis were performed, showing quite robust results for the recruitment, spawning stock biomass and F (Figure 4.2.2.6.3.3).

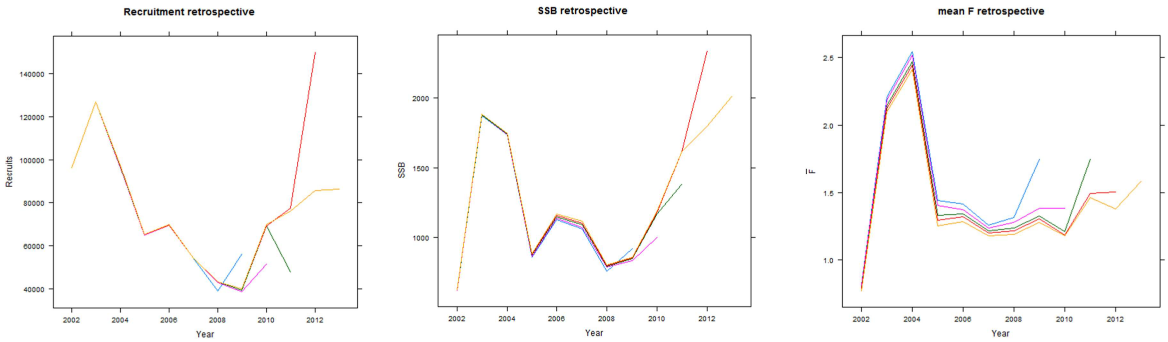


Figure 4.2.2.6.3.3. Red mullet in GSA 6. Retrospective analysis for recruitment, SSB and F.

Table 4.2.2.6.3.2 shows the current F (F_{curr}) as well as the reference point $F_{0.1}$ (as a proxy of F_{MSY}) calculated during STECF EWG 13-19.

Table 4.2.2.6.3.2. Red mullet in GSA 6. Current F and reference point ($F_{0.1}$).

$F_{curr\ (0\text{-}2,\ 2011\text{-}2013)}$	1.47
$F_{0.1}$ (STECF EWG 13-19)	0.45

4.2.2.7 Data quality

Information about catches and length and age frequency distributions was available through the Official Data Call for all the years. Effort information was available only for 2009-2013. MEDITS data was also available.

4.2.2.8 Scientific advice

Fishing mortality shows similar values for the last years, lower than the maximum found in 2004. Both the recruitment and the spawning stock biomass show an increasing trend, probably related to the decrease in the OTB effort, the gear with the highest catches for *M. barbatus* in GSA 6.

4.2.2.9 Short term considerations

4.2.2.9.1 State of the stock size

The stock abundance showed a maximum of $155 \cdot 10^6$ individuals in 2003 with a deacreasing trend until reaching a minimum of $52 \cdot 10^6$ individuals in 2009, followed by an increasing trend since then. The SSB showed a maximum of 1884 tons in 2003 and minimum values of 800-860 tons in 2008-2009, followed by an increasing trend, reaching the highest values of the data series in 2013 (2012 tons). No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.2.9.2 State of recruitment

Recruitment showed a maximum of $127 \cdot 10^6$ individuals in 2003, with a decreasing trend until reaching a minimum of $39 \cdot 10^6$ individuals in 2009, followed by an increasing trend since then.

4.2.2.9.3 State of exploitation

The current F (1.47) is larger than $F_{0.1}$ (0.45), which indicates that red mullet in GSA 6 is exploited unsustainably.

4.2.2.10 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.3 STOCK ASSESSMENT OF BLUE WHITING IN GSA 6

4.2.3.1 Stock Identification

Due to insufficient information about the stock structure of blue whiting in the western Mediterranean Sea, this stock was assumed to be confined within the boundaries of the GSA 6 (Figure 4.2.3.1.1).

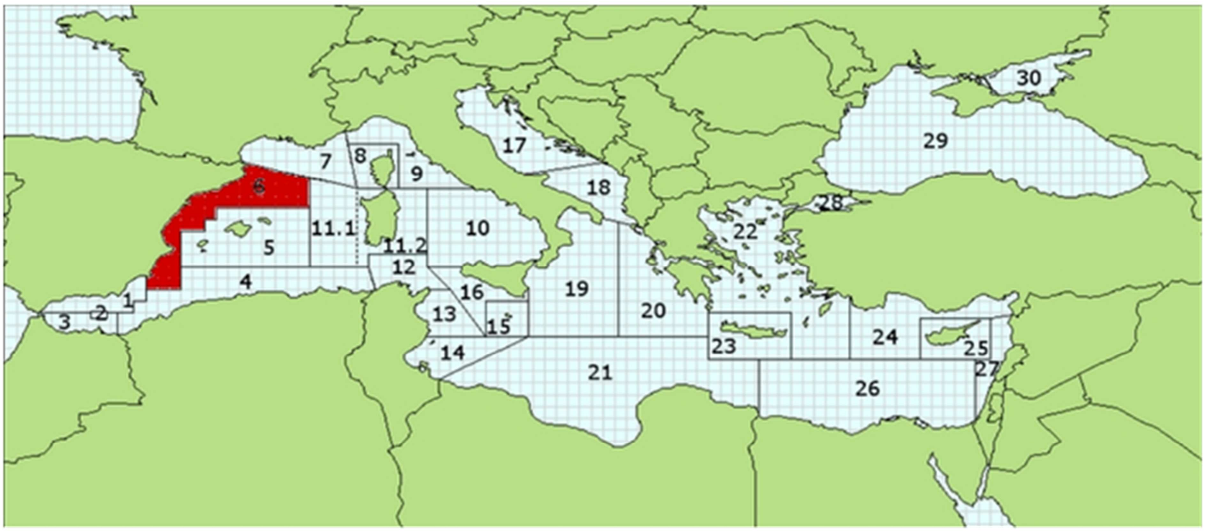


Figure 4.2.3.1.1. Geographical location of GSA 6.

4.2.3.2 Growth

The growth parameters used to run assessment are the set of parameters available from GSA 9, and are the following: L_{inf}=45.25 cm, k=0.35, t_0=0. Length-weight relationships: a=0.004, b=3.154.

4.2.3.3 Maturity

The spawning season of blue whiting is restricted to the winter months (December to February), with the spawning peak in January (García et al., 1987). No information was available about size at first maturity. The value of 18 cm was derived from Fishbase (www.fishbase.org). Age at maturity was obtained through size to age transformation. The estimated age at first maturity is around two years.

Age class	**0**	**1**	**2**	**3**	**4**	**5+**
Maturity	0	0.013	0.61	1	1	1

4.2.3.4 Fisheries

4.2.3.4.1 General description of Fisheries

No updated information was available to STECF EWG 14-09. Blue whiting is a demersal species important locally, especially in the northern part of GSA 6 and it is mainly exploited by the otter trawlers.

4.2.3.4.2 Management regulations applicable in 2013

Trawl fisheries in GSA 6 are regulated by “Orden AAA/2808/2012” published in the Spanish Official Bulletin (BOE nº 313 29 December 2012) containing an Integral Management Plan for Mediterranean fishery resources. The traditional fisheries regulations are: the daily and weekly fishing effort limited to 12 hours per day five days a week; trawl cod end 40 mm square mesh or Management regulations applicable in 2014. No specific regulations are enforced for this species.

4.2.3.4.3 Catches

4.2.3.4.4 Landings

Landings data were reported to STECF EWG 14-09 through the DCF. The majority of the landings corresponded to bottom otter trawlers; landings reported for purse seine represented less than 0.15% of the total landings.

Table 4.2.3.4.4.1. Blue whiting in GSA 6. Annual landings (t) by gear in GSA 6 from the DCF data.

	PS	**OTB**			
		TOTAL	**DEMSP**	**DWSP**	**MDDWSP**
2002	0.4	2409			
2003		1276			
2004	1.3	2591			
2005	1.2	2222			
2006	4.3	4723			
2007	6.1	4448			
2008		2194			
2009		1528	1282.47	195.44	49.90
2010		1321	1150.68	127.06	43.09
2011		1936	1495.55	121.03	319.56
2012		829.62	689.31	52.25	88.07
2013		1020.74	902.45	64.10	54.18

The time series of landings data (tons) by gear for the period 2002-2013 was shown in Figure 4.2.3.4.4.1. Maximum landings values were observed in 2006 and 2007 and minimum values in 2012.

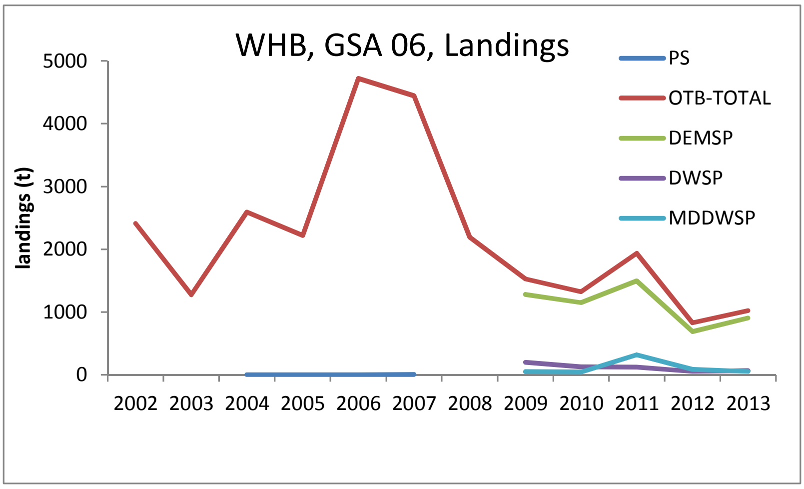


Figure 4.2.3.4.4.1. Blue whiting in GSA 6. Total annual landings by gear for the period 2002-2013.

DCF data on age structure of blue whiting from otter trawl in GSA 6 were available for the period 2009-2013, and are shown in Figure 4.2.3.4.4.2. This species is commercialized mainly from age 1 and recruitment is usually discarded.

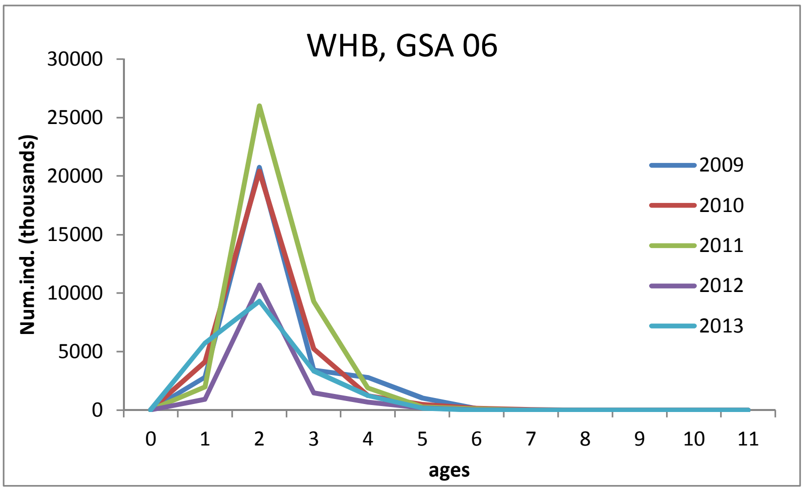


Figure 4.2.3.4.4.2. Blue whiting in GSA 6. Age frequency distribution of the landings from 2009 to 2013 as obtained from the DCF.

DCF data on length structure of blue whiting from otter trawl in GSA 6 were available for the period 2009-2013, and are shown in Figure 4.2.3.4.4.3.

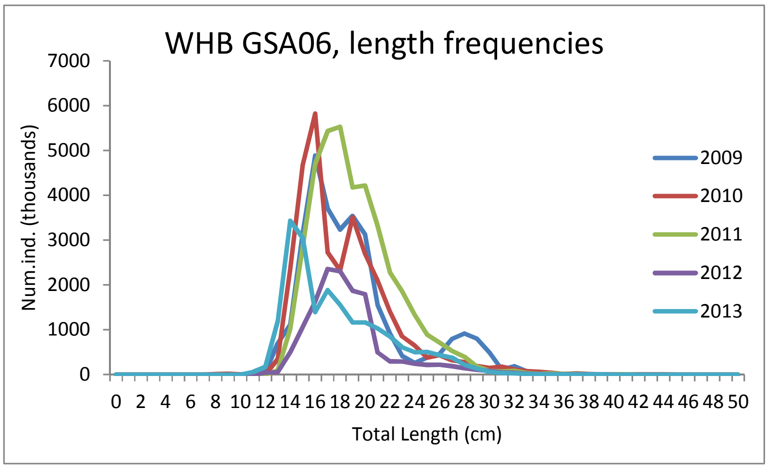


Figure 4.2.3.4.4.3. Blue whiting in GSA 6. Length frequency distribution of the landings from 2009 to 2013 as obtained from the DCF.

Information on OTB discards was available from 2009 to 2013 and it is shown in Table 4.2.3.4.4.2. The amount of discards has been increasing in the last years, and the amount in 2013 is not negligible (15%). Nevertheless, no data on the length frequency of discards is available.

Table 4.2.3.4.4.2 Blue whiting in GSA 6. Discards data in tons.

	OTB	**OTB-discards**
2009	1528	0.01
2010	1321	0.43
2011	1936	105.61
2012	829.63	46.01
2013	1020.74	152.99

4.2.3.4.5 Fishing Effort

Trawl (OTB) fishing effort data for GSA 6 was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2013 in the new data call, but due to differences respect to data provided in previous meetings we have used the series of previous data (see chapter 4.2.3.8 Data quality). Data for the length classes VL1224 and VL2440 are shown in the following table and figure. The reduction in fishing effort is apparent, in accordance with the Integral Plan previously mentioned aiming to reduce fishing effort. The number of vessels and GT days at sea of OTB fleet in GSA 6 in the period 2009-2012 by fleet segment is presented in Table 4.2.3.4.5.1

Table 4.2.3.4.5.1. Blue whiting in GSA 6. Number of vessels, nominal fishing effort and capacity.

	2009	2010	2011	2012
Nb of Vessels	558	546	540	540
Nominal effort kW x days at sea (000s)	28339	26306	24805	23553
GT x days at sea (000s)	6063	5673	5343	5109

4.2.3.5 Scientific surveys

4.2.3.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 6 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002). In GSA 6 the following number of hauls was reported per depth stratum in the DCF 2014 data call:

Table 4.2.3.5.1.1. Number of hauls per year and depth stratum in GSA 6, 1994-2013.

DEPTH_STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002
050-100	21	27	27	25	27	28	30	29	34
100-200	10	18	16	14	12	16	18	18	19
200-500	9	15	9	10	6	12	11	15	16
500-800	8	11	10	8	4	10	7	8	7

DEPTH_STRATUM	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
050-100	37	30	31	33	26	29	28	20	28	35	38
100-200	20	16	17	18	14	20	20	12	20	23	24
200-500	17	15	14	17	10	13	14	10	15	18	17
500-800	11	11	8	12	9	9	7	8	8	8	8

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai2 * si 2 / ni) / A2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum n=number of hauls in the GSA
Yi=mean of the i-th stratum

Yst=stratified mean abundance V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

4.2.3.5.2 Geographical distribution

No specific analyses were conducted during EWG 14-09.

4.2.3.5.3 Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 2001-2013 was used to derive indices of abundance and biomass for blue whiting in GSA 6. Both abundance and biomass have fluctuated in the area during this period with no clear trend.

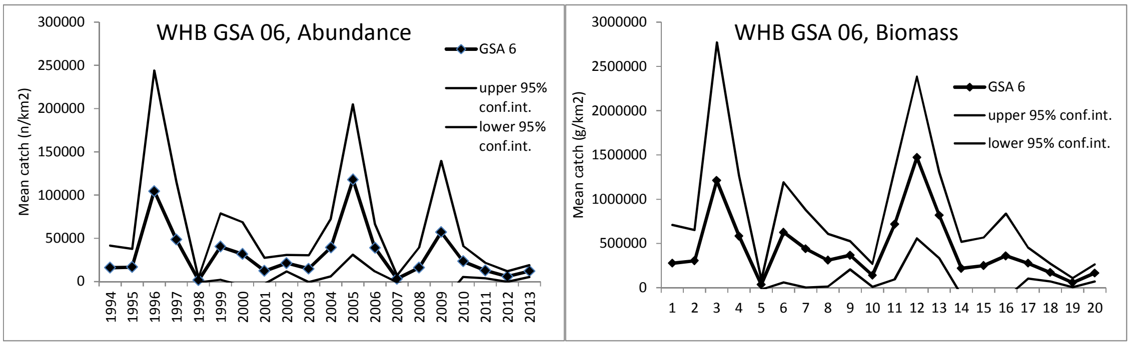


Figure 4.2.3.5.3.1. Blue whiting in GSA 6. Abundance and biomass indices from the MEDITS survey.

4.2.3.5.4 Trends in abundance by length or age

The following Figures 4.2.3.5.4.1, 2 and 3 display the stratified abundance indices of blue whiting in GSA 6 in 1994-2001, 2002-2009 and 2010-2013 respectively.

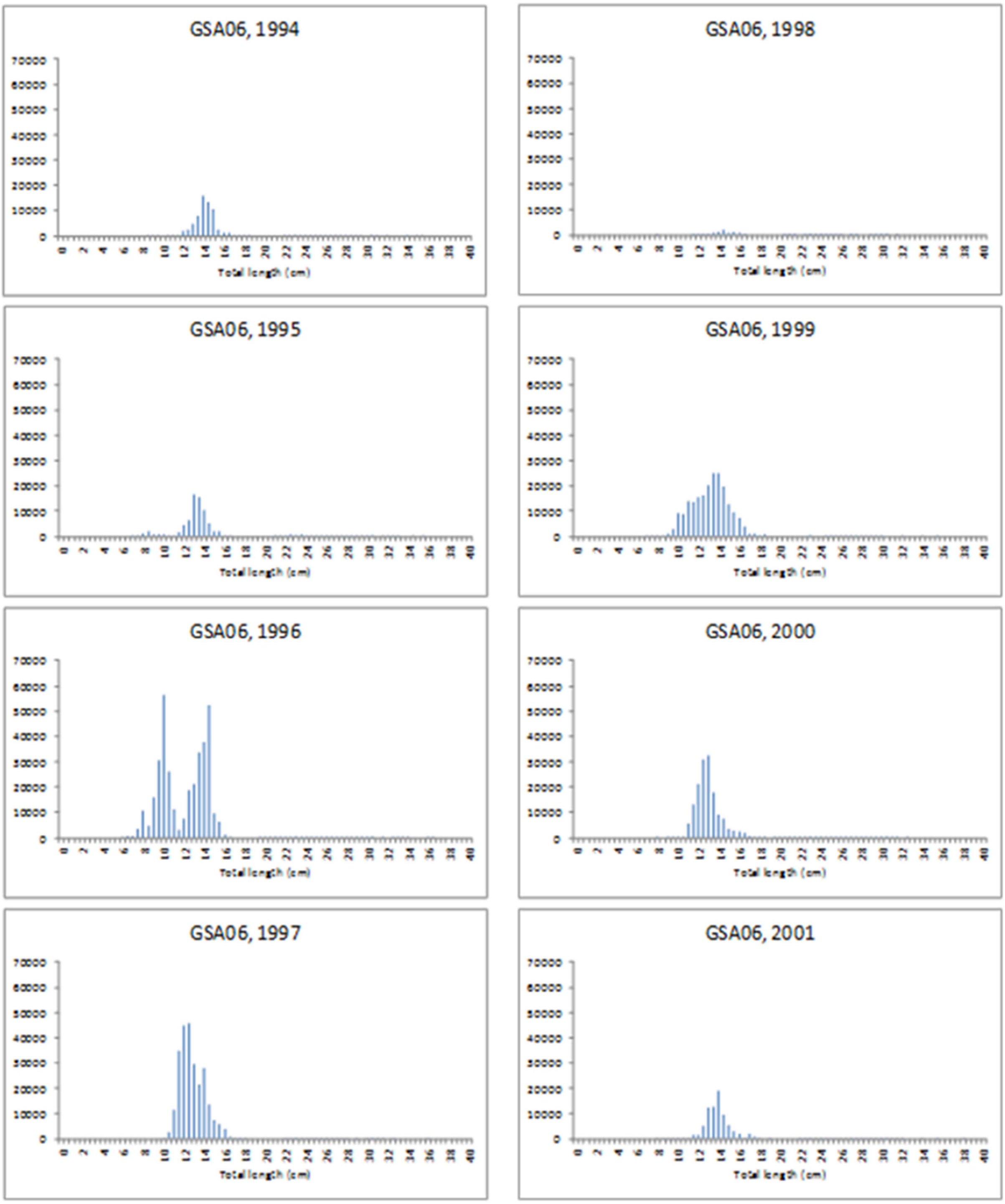


Figure 4.2.3.5.4.1. Blue whiting in GSA 6. Stratified abundance indices by size, 1994-2001.

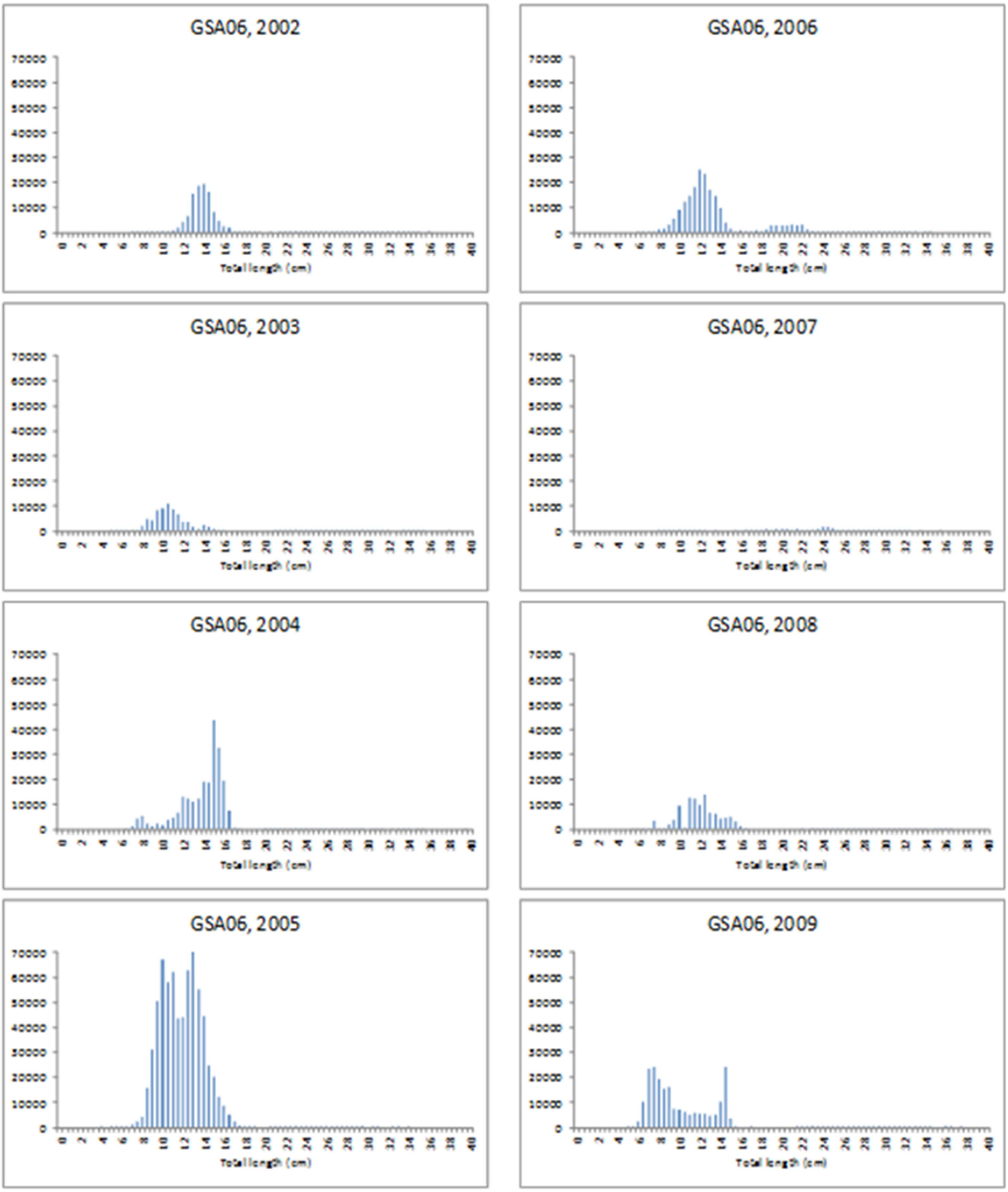


Figure 4.2.3.5.4.2. Blue whiting in GSA 6. Stratified abundance indices by size, 2002-2009.

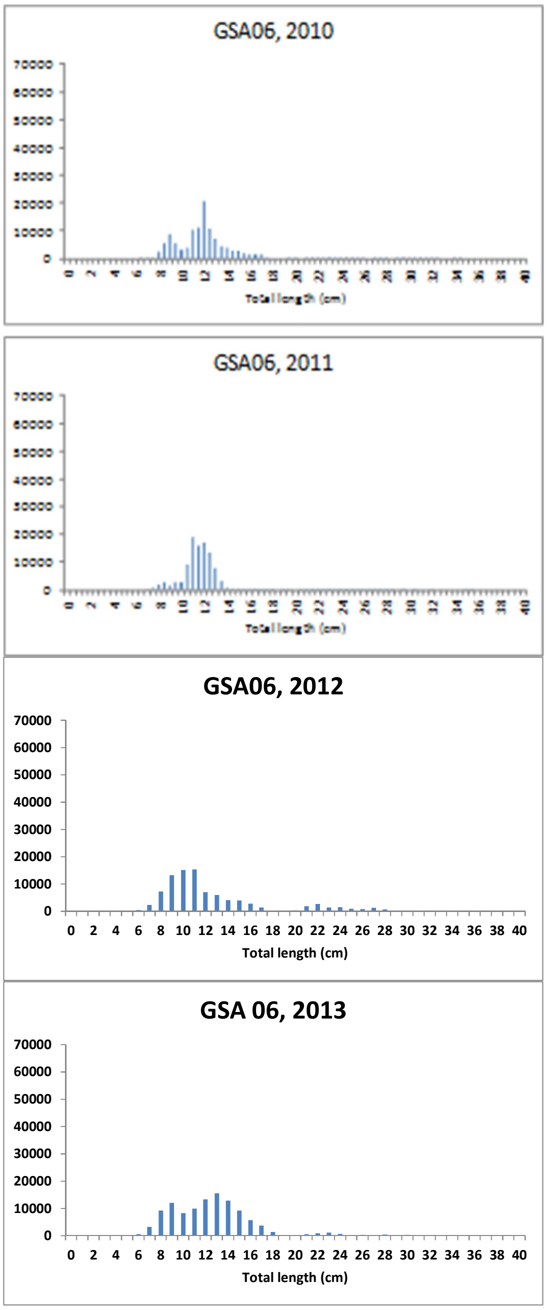


Figure 4.2.3.5.4.3. Blue whiting in GSA 6. Stratified abundance indices by size, 2010-2013.

4.2.3.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.3.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.3.6 Assessment of historic stock parameters

4.2.3.6.1 Method: XSA

4.2.3.6.2 Justification

FLR libraries were employed in order to carry out an XSA based assessment (Darby and Flatman 1994). This stock was assessed for the first time during in STECF 12-19 EWG 12-10: LCA (VIT program from Lleonart and Salat, 1992) was performed using as input data the period 2009-2011. XSA has been carried out for the first time for this stock in 2014 (STECF EWG 14-09) using as input data the period 2009-2013.

4.2.3.6.3 Input parameters

The growth parameters used for VBGF were L_{inf}= 45.25 cm TL; K = 0.35 yr^{-1}; t_0= 0 yr (GSA 9 parameters). The length-to-weight coefficients used were those estimated by the GSA 9: a= 0.004, b= 3.154).

Numbers at age were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software. Commercial landings of blue whiting are exclusively obtained by the trawl fleet. The source of commercial landings is the DCF. The tuning parameters (MEDITS) were calculated by transforming standardized MEDITS length distributions to ages using L2Age4 software.

Table 4.2.3.6.3.1. Blue whiting in GSA 6. Catches by year with SOP corrections.

Captures					
age	2009	2010	2011	2012	2013
all	1733.9	1546.45	2126.38	697.39	907.03
SOP correction	1527.8	1320.83	1936.15	829.62	1020.74
	0.88	0.85	0.91	1.19	1.13

Table 4.2.3.6.3.2 lists the input parameters to the XSA, namely catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) were computed with the PROBIOM routine.

Table 4.2.3.6.3.2. Blue whiting in GSA 6. Input data to the XSA model.

Catch number at age (thousands)

	2009	2010	2011	2012	2013
0	573.2	290.4	70.5	80	1087.4
1	25579	28055.8	34289	12405.2	16065.9
2	3959	2759.4	5161.3	1296.4	2546.9
3	784.3	529.7	259.8	169.2	116.7
4	15.7	69.2	38.7	14.3	10
5+	0	20.2	3.4	3.3	1.6

Weight at age (kg)

	2009	2010	2011	2012	2013
0	0.014	0.013	0.015	0.013	0.014
1	0.039	0.038	0.043	0.04	0.035
2	0.14	0.117	0.112	0.121	0.118
3	0.215	0.227	0.225	0.218	0.214
4	0.345	0.334	0.331	0.348	0.328
5+	0.464	0.51	0.47	0.427	0.448

Maturity and natural mortality vectors.

	0	1	2	3	4	5+
Maturity	0	0.013	0.61	1	1	1
M	1.179	0.525	0.394	0.338	0.307	0.287

MEDITS number at age

		0	1	2	3
2009	1	487.3	91.9	77.2	5.7
2010	1	530.2	213.1	18.8	6.1
2011	1	725.9	206.3	39.8	0
2012	1	650.5	191.9	60.7	2.3
2013	1	676.9	388.4	23.3	2.8

4.2.3.6.4 Results

Sensitivity analyses were conducted to assess the effect of the main parameters, i.e. shrnkage (fse) and age above which q is independent from age (qage). Values ranging from 0.5 to 2.5 (0.5 increasing) for the shrinkage and from 0 to 1 for the qage parameter have been tested. Comparison of trends between the settings has been done. Different combinations between the set of settings that looked more stable were tested.

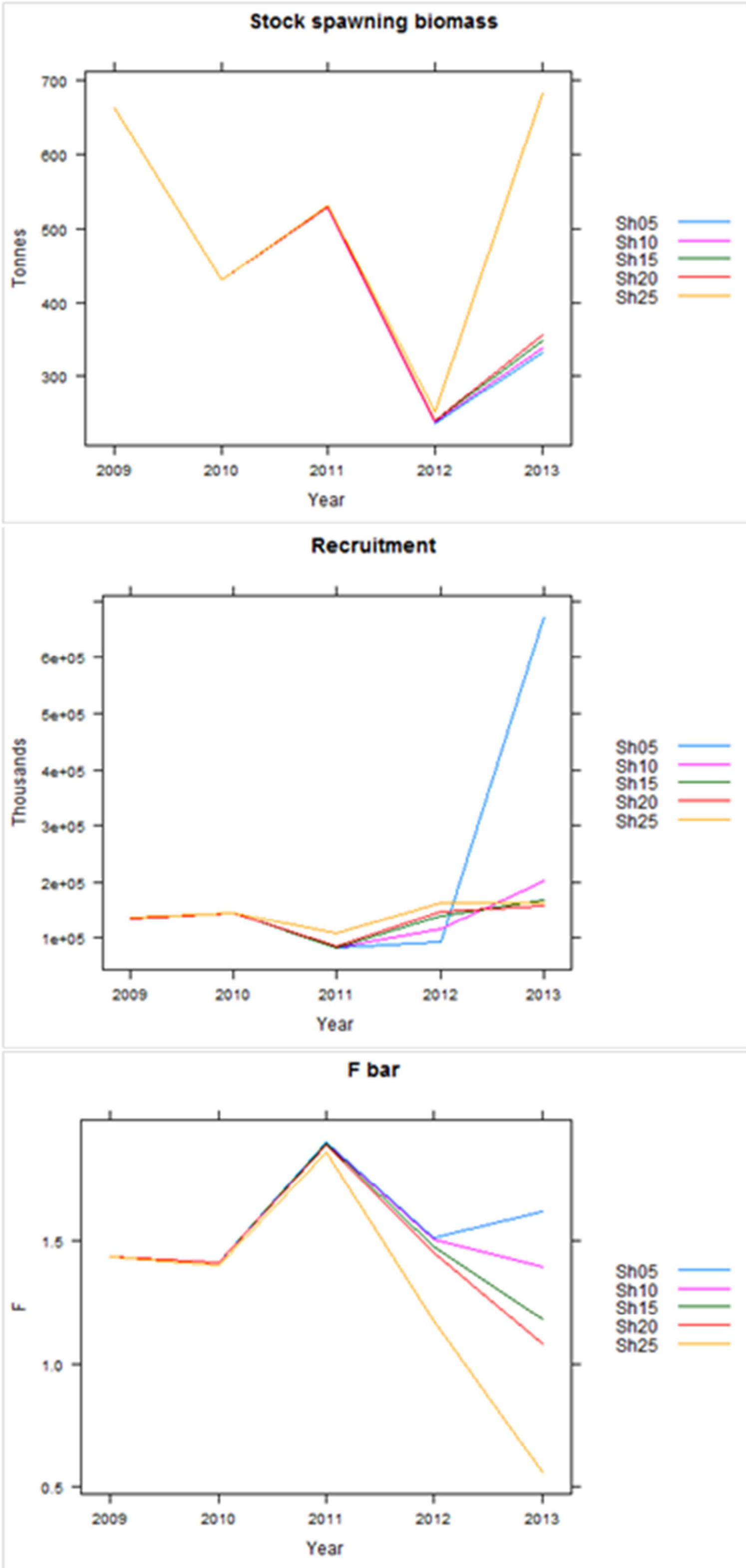


Figure 4.2.3.6.4.1. Blue whiting in GSA 6. Sensitivity on shrinkage weight.

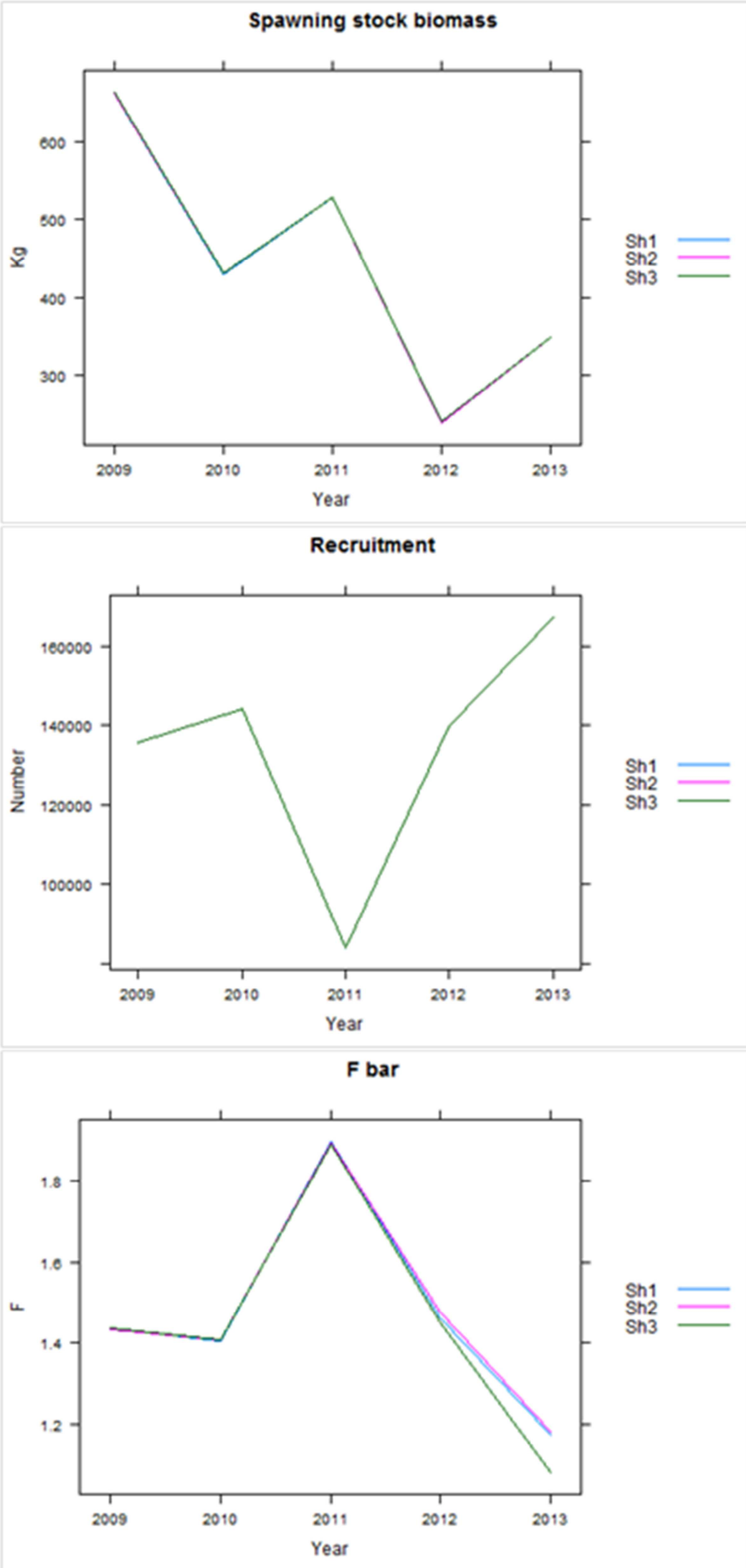


Figure 4.2.3.6.4.2. Blue whiting in GSA 6. Sensitivity for different shrinkage ages.

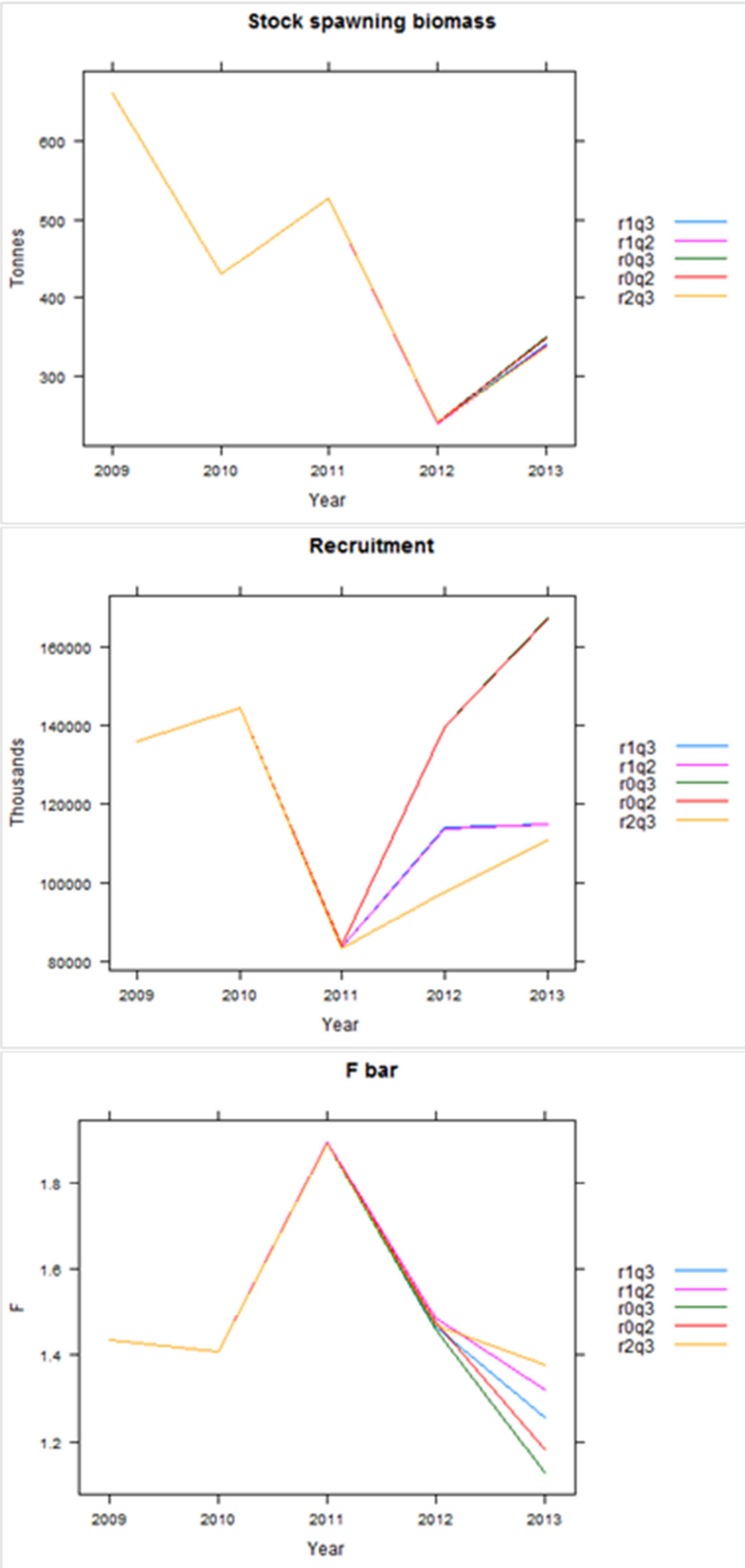


Figure 4.2.3.6.4.3. Blue whiting in GSA 6. Sensitivity for different rage and qage.

As a result, the settings that minimized the residuals and showed the best diagnostics output were used for the final assessment, and are the following:

Fbar = 0-3, fse = 1.5, rage = 0, qage = 3, shk.yrs = 2, shk.ages = 2

The residuals pattern of the MEDITS trawl survey is shown in Figure 4.2.3.6.4.4

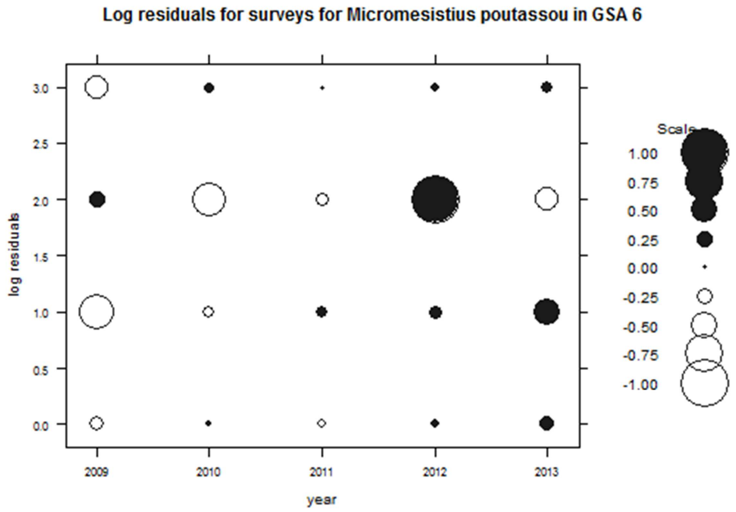


Figure 4.2.3.6.4.4. Blue whiting in GSA 6. XSA residuals for the MEDITS survey from 2009 to 2013.

Retrospective analysis was not performed due that in this case we have only 5 years of data. The results of the XSA are shown in the following figure:

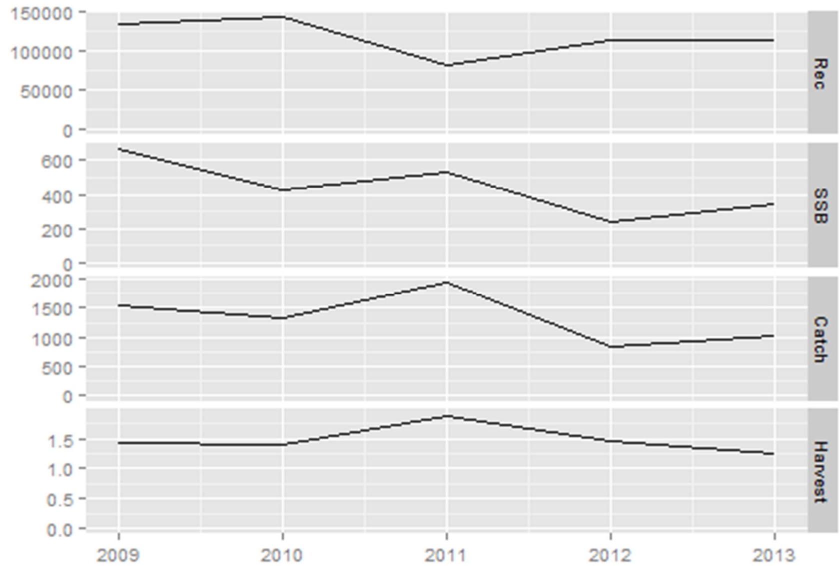


Figure 4.2.3.6.4.5. Blue whiting in GSA 6. XSA results (fishing mortality, recruitment, SSB, and yield).

In the tables 4.2.3.6.4.1 and 2 it is provided the population estimates of *Micromesistius poutassou* obtained by XSA.

Table 4.2.3.6.4.1. Blue whiting in GSA 6. Stock numbers at age (thousands) as estimated by XSA.

Year	0	1	2	3	4	5+
2009	135773	34935	5135	926	19	0
2010	144368	41482	3331	598	77	21
2011	83619	44268	6108	311	45	4
2012	113991	25684	2174	260	22	5
2013	114865	35009	3843	200	15	2

Table 4.2.3.6.4.2. Blue whiting in GSA 6. XSA summary results.

Year	Recruitment (thousands)	TB (t)	SSB (t)	Fbar	F at age					
				(0-3)	Age0	Age1	Age2	Age3	Age4	Age5+
2009	135773	4188	662	1.79	0.007	1.825	1.756	2.151	1.997	1.997
2010	144368	4015	430	1.68	0.003	1.391	1.977	2.260	2.272	2.272
2011	83619	3928	528	2.63	0.001	2.489	2.764	2.309	2.566	2.566
2012	113991	2839	240	1.68	0.002	1.375	1.993	2.497	2.301	2.301
2013	114865	3336	341	1.75	0.019	1.113	2.387	1.508	1.969	1.969

No SSB/R relationship could be estimated with only 5 data years; for this reason no medium term forecast has been performed.

The XSA results summarized in Table 4.2.3.6.4.2 and in Figure 4.2.3.6.4.5 show a slight decrease in recruitment (specially in 2011) and in the total biomass during the analysed period, a fluctuation on SSB and an estimated F around 1.9 with a maximum value on 2011. F_{cur} (1.52) was computed as the geometric mean of the last 3 years.

4.2.3.7 Long term prediction

4.2.3.7.1 Justification

To predict the effect of changes in fishing effort of future yields and to define reference points F_{01} (as a proxy for F_{MSY}) and F_{max} a Yield per Recruit analysis (YPR) was carried out.

4.2.3.7.2 Input parameters

The same population parameters and exploitation pattern derived from the final XSA model were used as input for the yield per recruit analysis.

age	0	1	2	3	4	5+
stock weight (kg)	0.014	0.039	0.122	0.220	0.337	0.464
catch weight (kg)	0.014	0.039	0.122	0.220	0.337	0.464
maturity ratio	0	0.013	0.61	1	1	1
M	1.179	0.525	0.394	0.338	0.307	0.287

4.2.3.7.3 Results

The results of the YPR in terms of $F_{0.1}$ and F_{max} were respectively 0.16 and 0.27. The complete results are presented in Table 4.2.3.7.3.1. The Y/R curve is shown in the Figure 4.2.3.7.3.1.

Table 4.2.3.7.3.1. Blue whiting in GSA 6. YPR results.

refpt	harvest	Yield (kg)	SSB (kg)
virgin	0.000	0.000	0.185
msy	0.275	0.017	0.045
F_{01}	0.159	0.016	0.074
F_{max}	0.275	0.017	0.045
Spr0.30	0.224	0.017	0.056

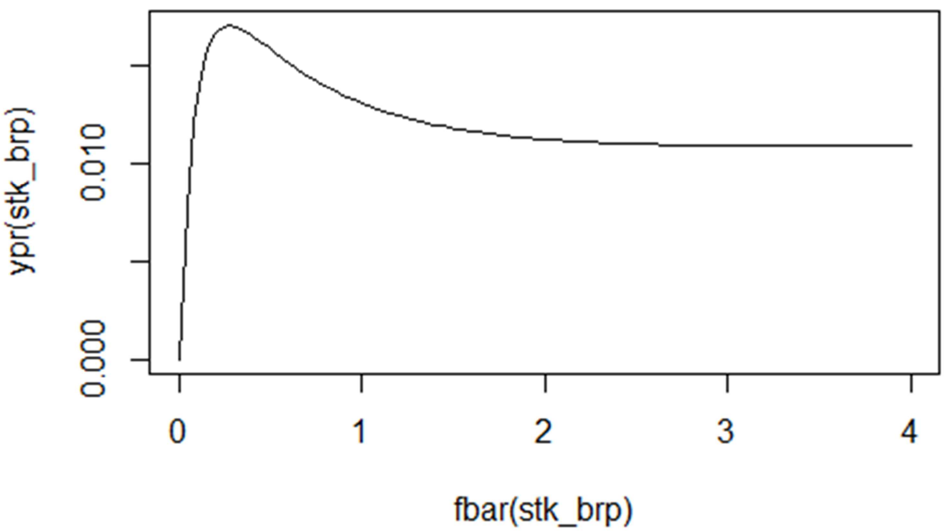


Figure 4.2.3.7.3.1. Blue whiting in GSA 6. YPR curve.

4.2.3.8 Data quality

Data from DCF 2013 as submitted through the Official data call in 2014 were used.

Fishing effort data

Fishing effort data should be checked. Values provided to EWG 14-09 were much higher than those submitted in previous meetings. As an example, see the number of OTB vessels in Table 4.2.3.8.1. When checked against the values reported by the autonomous governments of Catalonia, Valencia and Murcia (the zones included in GSA 6), the total number of vessels from these regions are similar to those reported in previous EWGs. For this reason, fishing effort data in the present report have been taken from the EWG 13-19 report.

Table 4.2.3.8.1. Number of OTB vessels by vessel length in GSA 6 in the period 2009-2013 according to the DCF. For comparison, the number of vessels in the EWG 13-19 report is given in the right column.

	VL0612	VL1218	VL1224	VL1824	VL2440	**EWG 14-09**	**EWG-13-19**
2009	21	141		451	230	**843**	**558**
2010	27		582		218	**827**	**546**
2011	27	136		393	200	**756**	**540**
2012	19	132		367	211	**729**	**540**
2013	19	127		362	205	**713**	

Discards data of 2009 to 2013 were available in catch but there are not length frequencies of these discards.

MEDITS data for blue whiting in GSA 6 used in the assessment were provided by experts participants to EWG 14-09, because MEDITS data were provided to the group without previous selection, which made the task of selection of the relevant data rather time consuming for those experts not familiar with the MEDITS data set.

4.2.3.9 Scientific advice

The current F (1.52) is larger than F_{MSY} (0.16), which indicates that blue whiting in GSA 6 is exploited unsustainably.

4.2.3.9.1 State of the stock size

The SSB is fluctuating along the series with an average of 440 t. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.3.9.2 State of recruitment

The recruitment estimated for 2014 is 102000 thousand individuals, lower than the series average (119000 thousand). However, recruitment may not be well estimated with the present assessment because the age 0 group (recruits) is not well represented in the commercial landings.

4.2.3.9.3 State of exploitation

The current F (1.52) is larger than F_{MSY} (0.16), which indicates that blue whiting in GSA 6 is exploited unsustainably. The size composition of landings indicates that the exploitation is based on age classes 1-2 (pre-adults and adults).

4.2.3.10 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.4 STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 6

4.2.4.1 Stock Identification

Due to the lack of information about the structure of Norway lobster (*Nephrops norvegicus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries. (Figure 4.2.4.1.1).

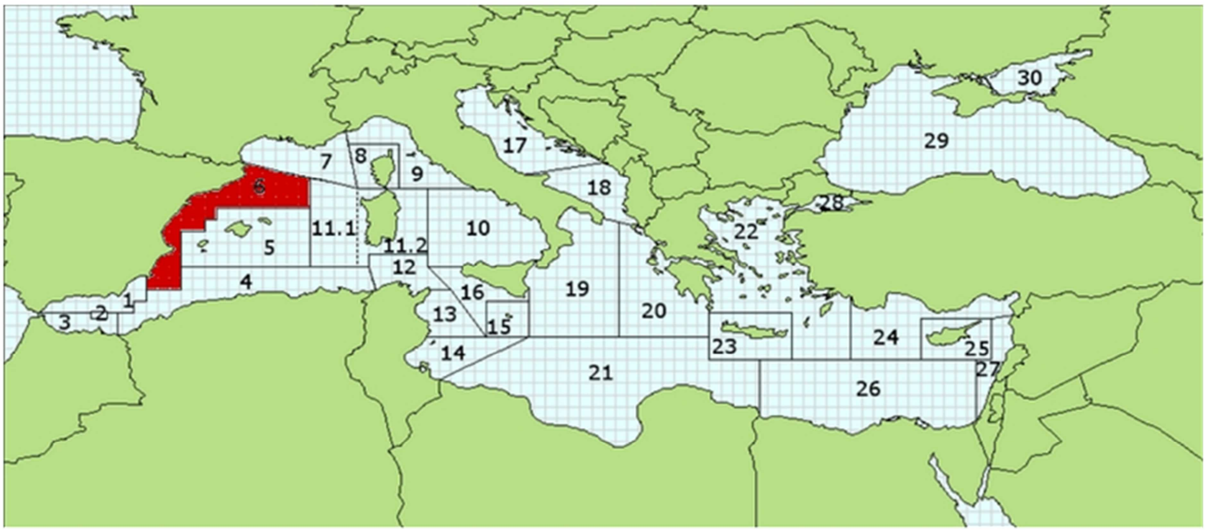


Figure 4.2.4.1.1. Geographical location of GSA 6.

4.2.4.2 Growth

Growth parameters and the length-weight relationship used were those already used in the previous assessment of this stock (STECF EWG 12-19). The values of the von Bertalanffy growth function parameters were L_{inf} = 72.1 mm CL, k= 0.169. The length-weight relationship are: a= 0.000373 and b=3.1576.

4.2.4.3 Maturity

Maturity ogive was the same used in the last assessment of this stock (STECF 12-19), which corresponds to these estimated for GSA 5.

Age class	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
Maturity ratio	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1

4.2.4.4 Fisheries

4.2.4.4.1 General description of Fisheries

Norway lobster is caught in GSA 6 exclusively by bottom trawlers fishing on the upper slope, between 350-600 m depth.

4.2.4.4.2 Management regulations applicable in 2014

Fishing license: number of licenses observed

Engine power limited to 316 KW or 500 HP: partial compliance

Mesh size in the codend (before June 1st 2010: 40 mm diamond: after June 1st 2010: 40 mm square or 50 mm diamond -by derogation-): full compliance
Time at sea (12 hours per day and 5 days per week): full compliance
Minimum landing size (MLS, EC regulation 1967/2006, 20 mm CL): mostly full compliance.

4.2.4.4.3 Catches

OTB data on discards are available for 2009-2013. Discards represent lower than 3.5% of the OTB catches in weight. Discards were assumed to be negligible in the present stock assessment.

4.2.4.4.4 Landings

OTB landings of Norway lobster in GSA 6 oscillated between minimum values around 200 t and maximum values around 500 t in the last years. (Figure 4.2.4.4.4.1).

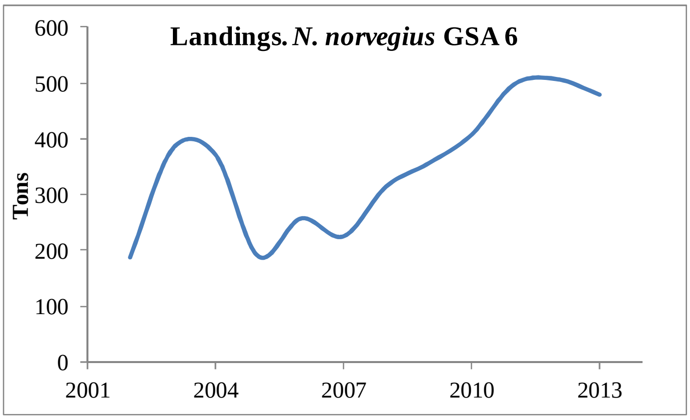


Figure 4.2.4.4.4.1. Norway lobster in GSA 6. Landings by gear and year.

The size frequency of the landings (average 2009-2013) is shown in Figure 4.2.4.4.4.2. It showed a mode around 27-30 mm CL. The percentage of individuals under the MLS is very low (less than 1%).

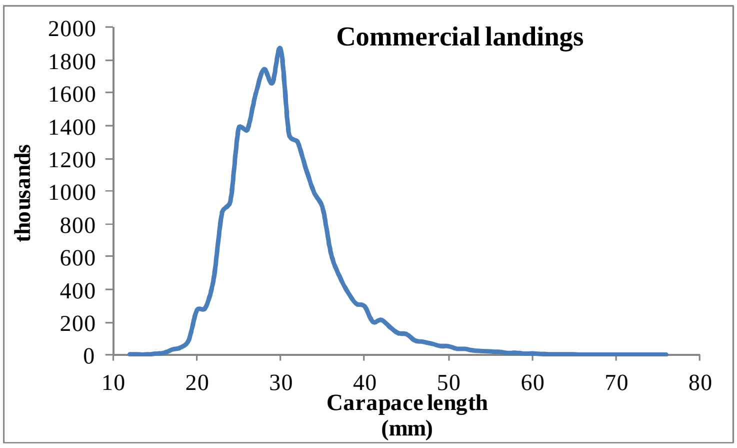


Figure 4.2.4.4.4.2. Norway lobster in GSA 6. Frequency distribution of the sampled commercial landings.

4.2.4.4.5 Fishing Effort

Data available for fishing effort covers the period 2009-2013. Both nominal effort and GT·days at sea for OTB showed a clear decreasing trend for the period considered. The variable number of boats should be considered by fishery as if we grouped, we could be overestimating the values, as a single boat can (and usually does) operate in the different OTB fisheries. The values are quite constant for the last years. (Figure 4.2.4.4.5.1).

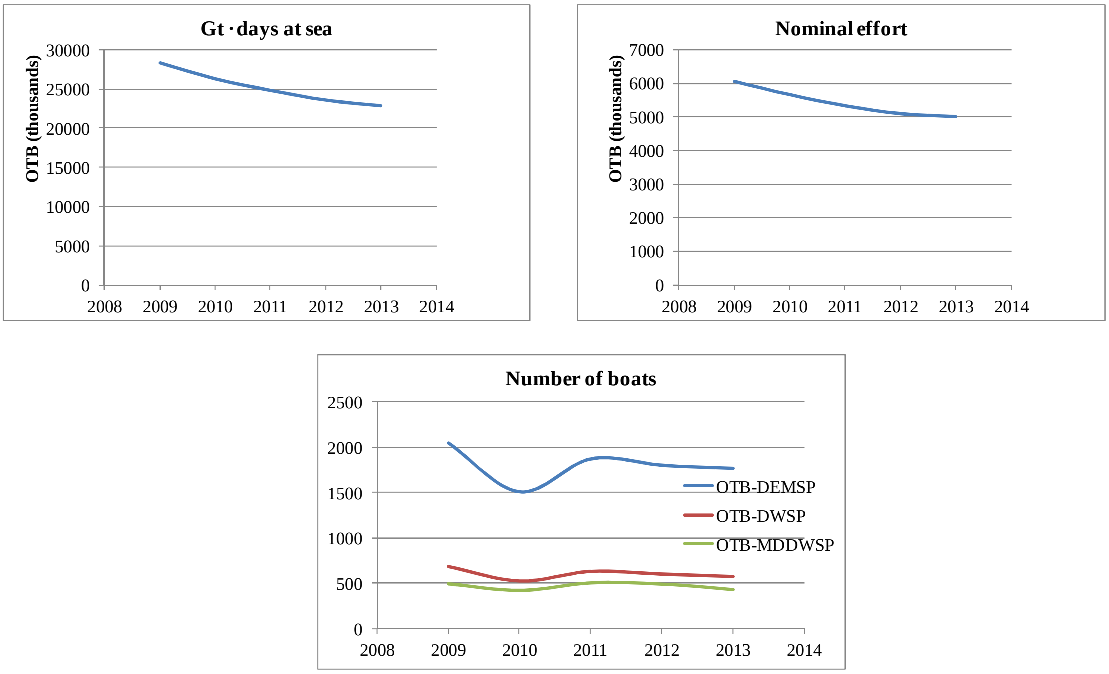


Figure 4.2.4.4.5.1. Norway lobster in GSA 6. Fishing effort by gear or metier.

4.2.4.5 Scientific surveys

4.2.4.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 6 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002).

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). The abundance and biomass indices were calculated through stratified means (Cochran, 1953; Saville, 1977) using the following formula:

$$Y_{st} = \Sigma\, (Y_i * A_i) \,/\, A$$

$$V(Y_{st}) = \Sigma\, (A_i^2 * s_i^2 \,/\, n_i) \,/\, A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum
n_i=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Y_i=mean of the i-th stratum
Y_{st}=stratified mean abundance
$V(Y_{st})$=variance of the stratified mean

The variation of the stratified mean is then expressed as the standard deviation. Length distributions were standardized through stratified means, following the same methodology applied for abundance and biomass.

4.2.4.5.2 Geographical distribution

No specific analyses were conducted during EWG 14-09.

4.2.4.5.3 Trends in abundance & biomass

Norway lobster standardized biomass in GSA 6 shows oscillations along the data series (Figure 4.2.4.5.3.1)

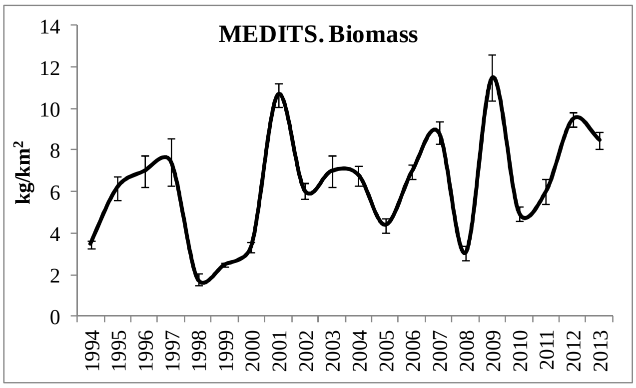


Figure 4.2.4.5.3.1. Norway lobster in GSA 6. Standardized biomass from the MEDITS surveys.

4.2.4.5.4 Trends in abundance by length or age

No specific analyses were conducted during EWG 14-09.

4.2.4.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.4.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.4.6 Assessment of historic stock parameters

4.2.4.6.1 Methods

The assessment has been performed with a pseudocohort analysis in VIT, for each available year (2009-2013). This assessment is an update of the one performed in 2012 (STECF EWG 12 19).

4.2.4.6.2 Input parameters

The data used in the assessment were: (i) Landings time series 2009-2012 from OTB; (ii) Age distributions obtained from slicing of length distributions 2009-2012 and (iii) Set of growth parameters used in STECF EWG 12-19.

The growth parameters used for VBGF were L_{inf}= 72.1 mm CL; k = 0.169 yr^{-1}. The length-weight coefficients used were a= 0.000373 and b=3.1576.

Numbers at age for the commercial fleet and the survey were estimated transforming the annual size distribution of the landings to ages using the VIT software.

Table 4.2.4.6.2.1 lists the input parameters to the pseudocohort analysis, namely catch at age, maturity and natural mortality at age.

Table 4.2.4.6.2.1. Norway lobster in GSA 6. Input parameters to the pseudocohort analysis.

Catch at age matrix

Age	2009	2010	2011	2012	2013
1	322	244	384	372	452
2	5310	7180	7070	10500	9900
3	5550	7940	10000	11000	10800
4	1970	2450	3310	2540	2560
5	746	728	828	831	792
6	243	262	365	299	266
7	93	131	201	145	83.9
8	33	61	68.7	97.8	43.5
9+	61	45	81.6	70.9	48.3

Maturity and natural mortality vectors.

Age class	1	2	3	4	5	6	7	8	9+
Maturity	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1
M	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21

4.2.4.6.3 Results

Stock abundance showed values between 80-140·10^6 individuals, with predominance of ages 1-3 in the stock. SSB showed values between 300-600 t. The highest values of F correspond to ages 3-6 (Figure 4.2.4.6.3.1, Table 4.2.4.6.3.1).

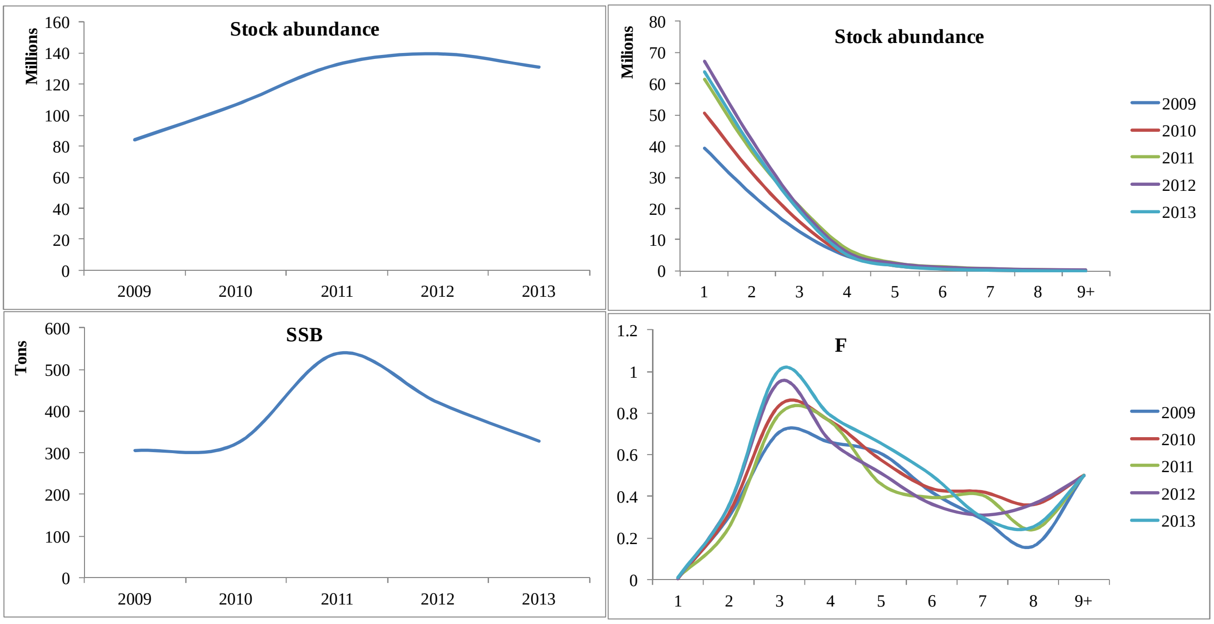


Figure 4.2.4.6.3.1. Norway lobster in GSA 6. Pseudocohort analysis results.

Table 4.2.4.6.3.1. Norway lobster in GSA 6. Pseudocohort analysis results.

	Population in number (thousands)	**Population in weight (tons)**	**SSB**	**F_{3-7}**
2009	83888	691	305	0.536
2010	106476	794	321	0.605
2011	132352	1084	538	0.563
2012	139334	1019	420	0.562
2013	130752	880	328	0.650

Table 4.2.4.6.3.2 shows the current F (F_{3-7}) and the reference point F_{01} (as a proxy of F_{MSY}) calculated during STECF EWG 12-19.

Table 4.2.2.6.3.2. Norway lobster in GSA 6. Current F and reference point ($F_{0.1}$).

$F_{curr\ (3-7,\ 2011-2013)}$	0.59
F_{01} (STECF EWG 12-19)	0.15

4.2.4.7 Data quality

Information about catches and length and age frequency distributions was available through the Official Data Call for all the years. Effort information was available only for 2009-2013. MEDITS data was also available.

4.2.4.8 Scientific advice

The data series is still too short to identify any clear trend in the population parameters. However, fishing mortality remains quite constant.

4.2.4.9 Short term considerations

4.2.4.9.1 State of the stock size

Stock abundance showed values between 80-140·10^6 individuals. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.4.9.2 State of recruitment

No information about recruitment is available.

4.2.4.9.3 State of exploitation

The current F (0.59) is larger than $F_{0.1}$ (0.15), which indicates that Norway lobster in GSA 6 is exploited unsustainably.

4.2.4.10 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.5 STOCK ASSESSMENT OF HAKE IN GSA 7

4.2.5.1 Stock Identification

Due to the lack of information about the structure of hake population in the western Mediterranean, this stock was assumed to be confined within the GSA 7 boundaries. (Figure 4.2.5.1.1).

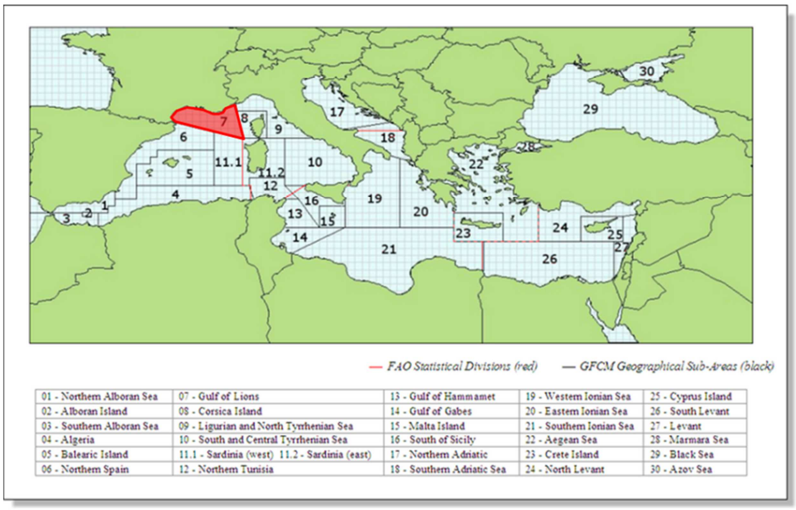


Figure 4.2.5.1.1. Geographical location of GSA 7.

4.2.5.2 Growth

The growth of European Hake (*Merluccius merluccius*) in the Gulf of Lions was recently re-estimated from tagging experiments carried out by IFREMER (Mellon-Duval et al., 2010). The new parameters have not been yet compared to a re-analysis of otoliths readings. Therefore, the data sent to the data call were in length and were converted in age using the length-to-age slicing functions available in the R package a4a. The growth parameters used during the EWG 14-09 are indicated in the following table.

	Females	Males
L_{inf}	100.7	72.8
K	0.236	0.233
t_0	-	-

4.2.5.3 Maturity

The maturity was calculated using data collected within the DCF.

Table 4.2.5.3.1. Hake in GSA 7. Maturity at age

	0	1	2	3	4	5
1998	0.06	0.23	0.72	0.92	0.99	1
1999	0.06	0.33	0.69	0.91	0.99	1
2000	0.06	0.34	0.74	0.92	0.99	1
2001	0.06	0.33	0.7	0.9	0.99	1
2002	0.05	0.25	0.67	0.91	0.99	1
2003	0.08	0.34	0.67	0.9	0.99	0.99
2004	0.06	0.32	0.7	0.9	0.98	0.99
2005	0.06	0.32	0.71	0.9	0.98	0.99
2006	0.07	0.37	0.78	0.91	0.98	0.99
2007	0.08	0.32	0.7	0.92	0.98	0.99
2008	0.09	0.22	0.65	0.91	0.98	1
2009	0.08	0.38	0.69	0.89	0.98	0.99
2010	0.08	0.29	0.65	0.89	0.98	0.99
2011	0.09	0.33	0.64	0.88	0.98	0.99
2012	0.11	0.27	0.64	0.89	0.98	0.99
2013	0.08	0.28	0.61	0.94	1	1

4.2.5.4 Fisheries

4.2.5.4.1 General description of Fisheries

Hake is one of the most important demersal target species for the commercial fisheries in the Gulf of Lions (GSA 7). In this area, hake is exploited by French trawlers, French gillnetters, Spanish trawlers and Spanish longliners. Since 1998, an average of 243 boats are involved in this fishery and, according to official statistics, the total annual landings for the period 1998-2013 have oscillated around an average value of 2008 tons (1690.03 tons in 2013). In 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species. Between 1998 and 2013, the number of French trawlers operating in the GSA 07 has decreased by 39%, while it decreased by 20 between 2010 and 2013.The French trawler fleet is the largest both for the number of boats and the catch realised (41% and 72%, respectively). The length of hake in the trawler catches ranges between 3 and 92 cm total length (TL), with an average size of 21 cm TL. The second largest fleet is the French gillnetters (41 and 14% respectively, range 13-86 cm TL and average size 39 cm TL), followed by the Spanish trawlers (11 and 8%, respectively, range 5-88 cm TL, and average size 24 cm TL), and the Spanish longliners (6 and 6%, respectively, range 22-96 cm TL and average size 52 cm TL).

The hake trawlers exploits a highly diversified species assemblage: Striped red mullet (*Mullus surmuletus*), red mullet (*Mullus barbatus*), angler fish (*Lophius piscatorius*), black-bellied angler fish (*Lophius budegassa*), European conger (*Conger conger*), poor-cod (*Trisopterus minutus capelanus*), fourspotted megrim (*Lepidorhombus boscii*), soles (*Solea spp.*), horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), seabreams (*Pagellus spp.*), blue whiting (*Micromesistius poutassou*) and tub gurnard (*Chelidonichtys lucerna*).

4.2.5.4.2 Management regulations applicable in 2013

French Trawlers:

Fishing license: fully observed

Engine power limited to 316 KW or 500 CV: Not full compliance

Cod-end mesh size (bottom trawl: square 40 mm or 50 mm diamond, by derogation): not fully observed

Fishing forbidden within 3 miles (France): not fully observed

Time at sea: fully observed

French gillnetters:

Fishing license: fully observed

Maximum length of net: not fully observed

Spanish trawlers:

Fishing license: fully observed

Engine power limited to 316 KW or 500 CV: not observed

Mesh size in the codend (before Jun 1st 2010: 40 mm diamond: after Jun 1st 2010: 40 mm square or 50 mm diamond, by derogation): fully observed

Fishing forbidden <50 m depth: fully observed

Time at sea: fully observed

Spanish longliners:

Fishing license: fully observed

Number of hook per boat: not fully observed

4.2.5.4.3 Catches

The catch is dominated by the french trawlers fleet. Since 1978, the catch has been slowly decreasing. In 2013, the total catch reached 1735 tons.

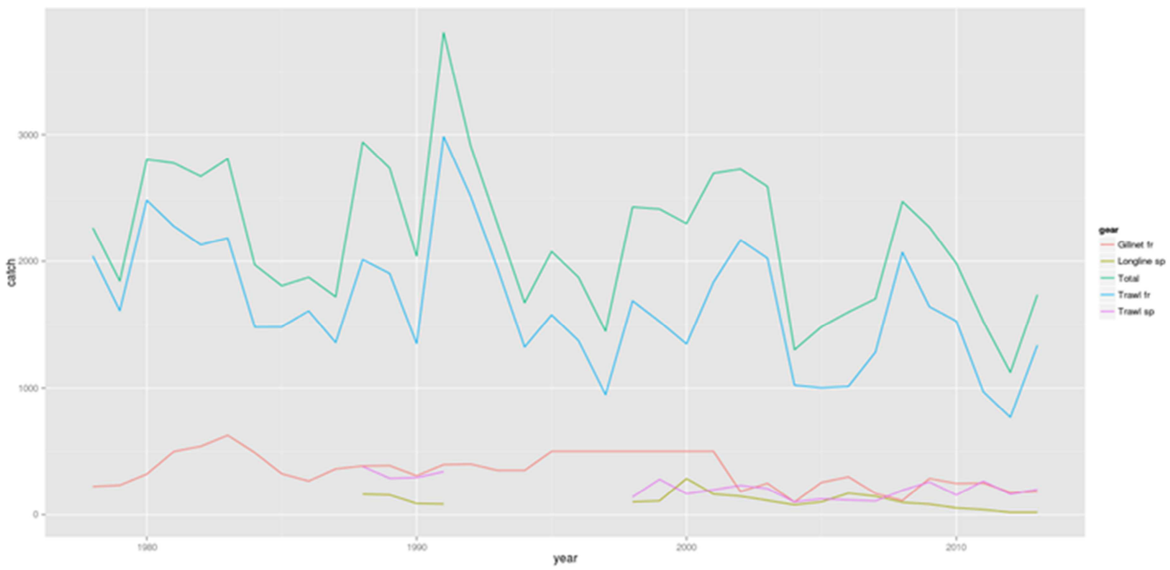


Figure 4.2.5.4.3.1. Hake in GSA 7. Catch (tons) by gear since 1978

Table 4.2.5.4.3.1. Hake in GSA 7. Annual catches (t) by gear (DCF data).

Gears/Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	1688	1525	1347	1835	2168	2024	1023	1002	1014	1282	2071	1642	1527	970	768	1337
OTB-Spanish	140	279	166	196	231	206	101	126	116	107	227	258	156	116	163	198
GNS-French	500	500	500	500	182	248	99	255	299	168	111	286	247	245	175	161
GTR-French					-	-	-	-	-	-	-	-	-	5	-	21
LLS-Spanish	101	109	285	163	146	112	78	101	170	143	97	84	54	29	18	18

4.2.5.4.4 Landings

Table 4.2.5.4.4.1. Hake in GSA 7. Annual landings (t) by gear (DCF data).

Gears/Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	1688	1525	1347	1835	2168	2024	1023	1002	1014	1282	1898	1633	1527	970	759	1292
OTB-Spanish	140	279	166	196	231	206	101	125	116	107	192	258	156	113	162	198
GNS-French	500	500	500	500	182	248	99	255	299	168	111	286	247	245	175	161
GTR-French	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	21
LLS-Spanish	101	109	285	163	146	112	78	101	170	143	97	83	53	29	18	18

4.2.5.4.5 Discards

The French discards were not included to the catch before 2008 as they represented a negligible amount.

Table 4.2.5.4.5.1. Hake in GSA 7. Annual discards (t) by gear (DCF data)

Gears/Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	-	-	-	-	-	0	-	0	0	0	173	9	-	-	9	46
OTB-Spanish	-	-	-	-	-	-	-	1	-	-	35	0	0	3	1	0
GNS-French	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GTR-French	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LLS-Spanish	-	-	-	-	-	-	-	-	-	-	-	1	1	-	0	0

4.2.5.4.6 Fishing Effort

For France, fishing effort data was provided on a yearly basis for OTB, OTM and GNS over the period 2003-2008. No data was available over 2009-2012. For Spain, fishing effort was provided for OTB and LLS over 2002-2012.

Table 4.2.5.4.6.1. Fishing effort (kW·days) by gear for France and Spain, 2009-2013.

Gear	2009	2010	2011	2012	2013
OTB-French	-	-	-	-	3121214
OTB-Spanish	1623651	1456054	1630298	1339565	1302803
GNS-French	-	-	-	3081607	30200
GTR-French	-	-	-	2908493	30507
LLS-Spanish	52941	175962	137453	115316	126165

4.2.5.5 Scientific surveys: MEDITS

4.2.5.5.1 Methods

Fishery independent information regarding the state of the hake in GSA 7 was derived from the international survey MEDITS. The data was assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This involves weighting the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma\, (Yi*Ai) / A$$
$$V(Yst) = \Sigma\, (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions were obtained by the sum of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the GSA strata.

4.2.5.5.2 Geographical distribution patterns

No specific analyses were conducted during EWG 14-09.

4.2.5.5.3 Trends in abundance & biomass

Fishery independent information regarding the state of the hake in GSA 7 was derived from the international survey MEDITS. Figure 4.2.5.5.3.1 displays the time series of abundance in GSA 7. No clear trend can be detected over the total period, but the 2013 value is one of the lowest observed in the time series. The size structure did not exhibit any substantial change in 2013 compared to the other years

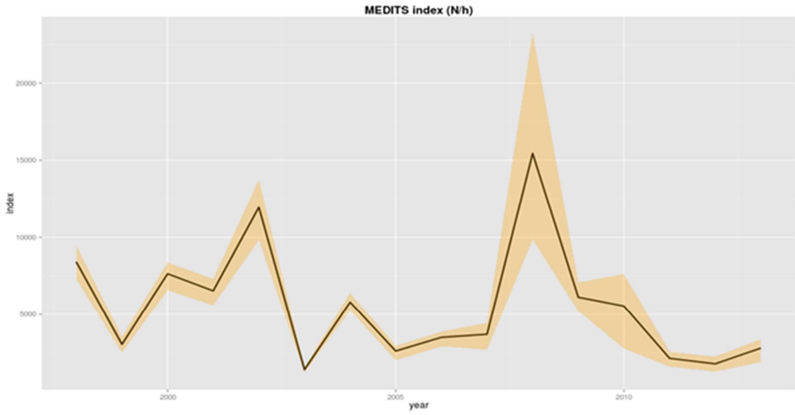


Figure 4.2.5.5.3.1. Hake in GSA 7. MEDITS abundance index (n/hour).

4.2.5.5.4 Trends in abundance by length or age

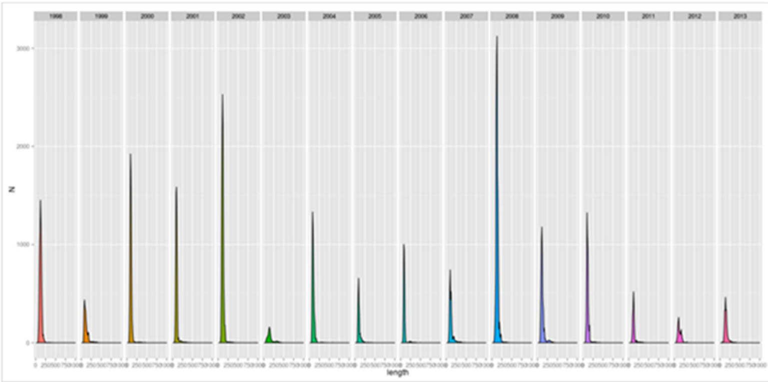


Figure 4.2.5.5.4.1. Hake in GSA 7. Size structure of the MEDITS abundance index (n/hour).

4.2.5.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.5.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.5.6 Assessment of historic stock parameters

4.2.5.6.1 Methods: a4a

4.2.5.6.2 Justification

During EWG 14-09 the stock assessment was performed over the period 1998-2013 using a4a model and the MEDITS index, over age classes ranging from 0 to 5+, as tuning fleet. An attempt was made to use the a4a model, developed by the Joint Research Center, instead of XSA for assessing the stock. a4a is a statistical catch at age model, which flexibility allows to fit a wide range of models to the data. Compared to XSA, a4a runs forward and allows to reach a better stability for last years estimates. As it is the first year this method was used, the results were compared to an XSA run.

4.2.5.6.3 Input parameters

The year 2013 was marked by a high catch of age 1, but the size structure of the catch remained consistent with the past data.

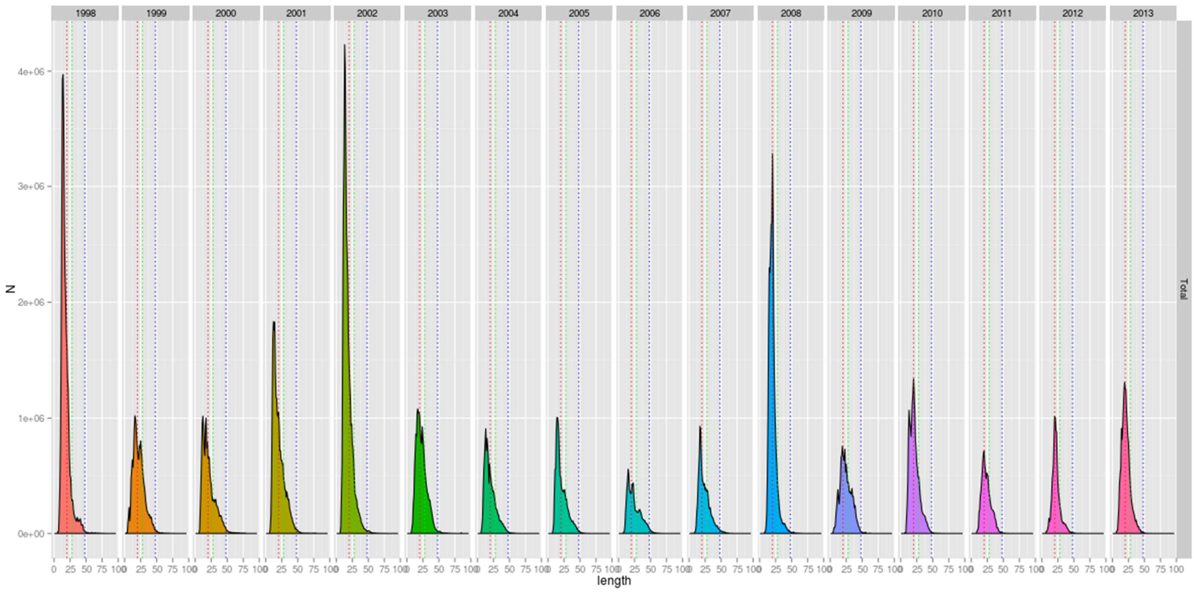


Figure 4.2.5.6.3.1. Hake in GSA 7. Length distribution of total catch.

Table 4.2.5.6.3.1. Hake in GSA 7. Catch at age in numbers (thousands).

	0	**1**	**2**	**3**	**4**	**5**	**6**
1998	21010	13203	1554	228	39	10	1
1999	6571	8996	2644	281	34	7	2
2000	7575	6992	2080	330	60	21	3
2001	12526	9850	2561	344	39	20	2
2002	24183	14310	2066	231	25	10	3
2003	6190	10323	2561	347	23	6	10
2004	6225	5269	1284	162	12	2	1
2005	5826	5691	1565	177	15	2	1
2006	2816	4452	1616	240	28	4	2
2007	3211	6097	1821	232	21	5	3
2008	12079	16923	1595	148	13	4	1
2009	3841	7804	2371	375	15	2	2
2010	7289	9621	1924	210	12	1	1
2011	2679	6188	1403	163	5	1	0
2012	2912	6558	915	101	4	1	0
2013	6287	10374	1440	13	3	0	0

Table 4.2.5.6.3.2. Hake in GSA 7. Weight at age (kg) in the catch and in the stock (kg).

	0	1	2	3	4	5	6
1998	0.024	0.086	0.351	0.687	1.776	2.603	2.048
1999	0.026	0.126	0.328	0.617	1.527	2.178	1.586
2000	0.024	0.13	0.379	0.735	1.841	2.708	1.555
2001	0.022	0.126	0.33	0.576	1.744	2.68	1.641
2002	0.022	0.094	0.309	0.658	1.66	2.071	2.696
2003	0.032	0.129	0.302	0.596	1.609	1.768	3.932
2004	0.023	0.12	0.323	0.586	1.161	1.358	2.259
2005	0.025	0.121	0.34	0.562	0.978	1.261	1.451
2006	0.03	0.144	0.421	0.645	1.053	1.204	1.664
2007	0.035	0.124	0.349	0.702	1.197	1.259	1.304
2008	0.037	0.083	0.3	0.681	1.355	1.859	1.471
2009	0.032	0.15	0.317	0.528	1.041	1.458	1.403
2010	0.032	0.112	0.285	0.519	1.235	1.183	1.35
2011	0.039	0.128	0.269	0.483	1.223	1.111	1.398
2012	0.043	0.103	0.279	0.561	1.121	1.171	1.284
2013	0.035	0.103	0.264	1.069	2.109	2.854	2.854

Table 4.2.5.6.3.3. Hake in GSA 7. Natural Mortality (M) at age estimated using PRODBIOM.

	0	1	2	3	4	5	6
1998	0.88	0.43	0.33	0.25	0.22	0.2	0.19
1999	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2000	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2001	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2002	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2003	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2004	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2005	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2006	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2007	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2008	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2009	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2010	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2011	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2012	0.88	0.43	0.33	0.25	0.22	0.2	0.19
2013	0.88	0.43	0.33	0.25	0.22	0.2	0.19

Table 4.2.5.6.3.4. Hake in GSA 7. MEDITS index at age (1998-2013).

	0	1	2
1998	7571	856	18
1999	2653	350	52
2000	7447	129	39
2001	6327	181	43
2002	11356	559	41
2003	958	369	73
2004	5669	134	24
2005	2451	153	22
2006	3373	95	31
2007	3387	330	55
2008	13318	2103	44
2009	5461	583	104
2010	5239	245	39
2011	1954	164	34
2012	1431	336	15
2013	1886	874	51

4.2.5.6.4 Results

In order to achieve the best results, the models were built with increasing complexity, until reaching results that were both statistically sound and biologically interpretable. The general specification of the model, in R language, was the following:

```
qmod <- list(~s(age, k = 3))
fmod <- ~ s(year,k=Y)+ s(age,k=A) + te(year, age, k = c(3, 3))
srmod <- ~factor(year)
vmod <- list(~ s(year, k = 4) + s(age, k = 3), ~ s(year,k=3)+s(age,k=3))
```

With Y [7; 13] and A [3; 5]

This model allowed for an effect of age for the catchability of the MEDITS index (submodel qmod). The model also allowed for an effect of time and age and a combined effect of both these variables on the fishing mortality estimates (submodel fmod). The stock recruitment was modelled as a factor, meaning that a value was estimated for each year independantly from each other (submodel sr mod). Finally, a submodel for the model variance was specified so that more flexibility, particulary for the first and last years and ages, could be allowed to the fit. The flexibility parameters for the smoother effects (k) for the qmod and vmod were set to constant values to ensure the fit of a reasonable model. Trials showed that other values were not as suitable. Then, the effect of the flexibility parameter for year and age in the fishing mortality submodel was browsed so that an objective selection of the final model could be achieved (Figure 4.2.5.6.4.1). To do so, the width of the residuals, the closeness of the residuals to zero and the BIC were used as metrics to rank the models. The best model was defined as the one that ranked the lowest, here the model number 12 specifying 10 for the flexibility parameter of the year effect and 5 for the flexibility parameter of the age effect.

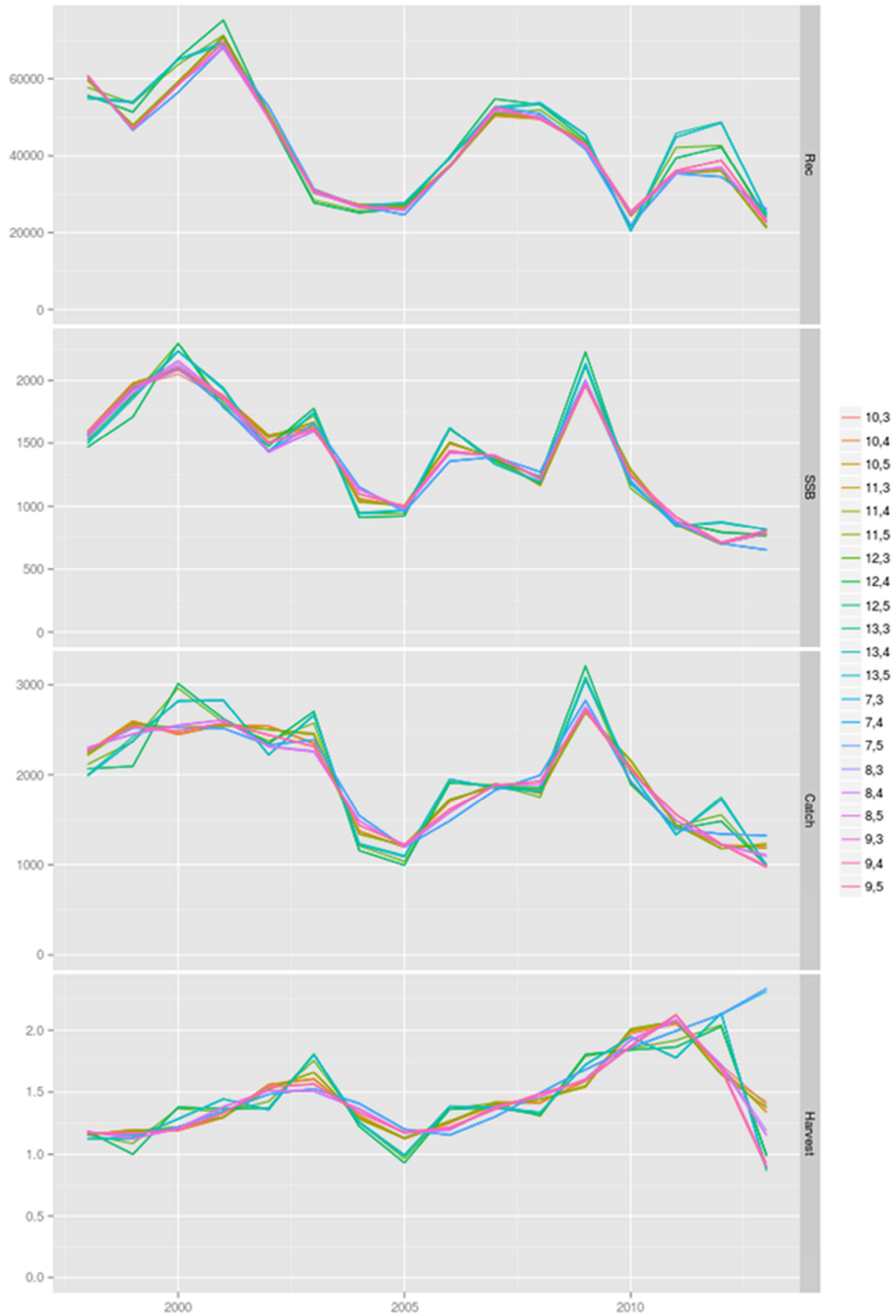


Figure 4.2.5.6.4.1. Hake in GSA 7. Model fit obtained for different values of the flexibility parameters for year and age.

Table 4.2.5.6.4.1. Hake in GSA 7. Value for the different metrics and ranking of the model.

Model number	Flexibility of the year effect	Flexibility of the age effect	width.res	zero.res	BIC	Rank
1	7.0	3.0	1.0	0.6	377.1	17.0
2	7.0	4.0	1.0	0.6	382.1	13.0
3	7.0	5.0	1.0	0.6	382.1	14.0
4	8.0	3.0	0.8	0.5	379.6	10.0
5	8.0	4.0	0.8	0.5	384.5	7.0
6	8.0	5.0	0.8	0.5	384.5	5.0
7	9.0	3.0	0.9	0.5	383.3	12.0
8	9.0	4.0	0.8	0.6	388.1	11.0
9	9.0	5.0	0.8	0.6	388.1	9.0
10	10.0	3.0	1.0	0.1	385.7	6.0
11	10.0	4.0	1.0	0.2	390.4	2.0
12	**10.0**	**5.0**	**1.0**	**0.2**	**390.4**	**1.0**
13	11.0	3.0	1.3	0.3	390.3	8.0
14	11.0	4.0	1.0	0.2	395.1	3.0
15	11.0	5.0	1.0	0.2	395.1	4.0
16	12.0	3.0	1.6	0.5	377.5	18.0
17	12.0	4.0	2.4	0.4	381.6	15.0
18	12.0	5.0	2.4	0.4	381.6	16.0
19	13.0	3.0	1.7	0.6	377.7	21.0
20	13.0	4.0	1.9	0.6	382.6	20.0
21	13.0	5.0	1.9	0.6	382.6	19.0

The best model selected by the procedure displayed consistent residuals for both the catch and the MEDITS data, with no obvious trend detected. The model was also able to predict both the catch and the MEDITS index, although the first ages were the less accurately predicted.

Table 4.2.5.6.4.2: Hake in GSA 7. Fishing mortality at age estimated by the a4a analysis.

	0	**1**	**2**	**3**	**4**	**5**
1998	0.4383	1.3387	1.4958	1.3541	0.9071	0.1926
1999	0.4022	1.3266	1.5806	1.4882	1.0113	0.2151
2000	0.3539	1.2589	1.5973	1.5635	1.0783	0.2299
2001	0.3410	1.3031	1.7563	1.7857	1.2508	0.2678
2002	0.3663	1.4962	2.1336	2.2501	1.6027	0.3454
2003	0.3393	1.4710	2.2079	2.4109	1.7489	0.3807
2004	0.2524	1.1513	1.8072	2.0386	1.5092	0.3331
2005	0.2012	0.9557	1.5567	1.8092	1.3701	0.3083
2006	0.2111	1.0319	1.7283	2.0629	1.6025	0.3696
2007	0.2290	1.1382	1.9427	2.3741	1.8971	0.4512
2008	0.2230	1.1149	1.9240	2.4008	1.9781	0.4875
2009	0.2485	1.2396	2.1490	2.7318	2.3254	0.5963
2010	0.3110	1.5364	2.6619	3.4411	3.0311	0.8115
2011	0.3256	1.5849	2.7334	3.5884	3.2747	0.9176
2012	0.2726	1.3030	2.2314	2.9722	2.8123	0.8261
2013	0.2197	1.0293	1.7479	2.3612	2.3174	0.7143

Table 4.2.5.6.4.3. Hake in GSA 7. Stock number at age estimated by the a4a analysis.

	0	**1**	**2**	**3**	**4**	**5+**
1998	60733	19966	2390	330	72	70
1999	47125	16252	3405	385	66	70
2000	58898	13074	2805	504	68	66
2001	70954	17148	2415	408	82	61
2002	50152	20926	3030	300	53	57
2003	30359	14422	3049	258	25	42
2004	26955	8969	2155	241	18	27
2005	26804	8687	1845	254	24	19
2006	37488	9092	2173	280	32	16
2007	50362	12591	2108	277	28	15
2008	49520	16613	2624	217	20	11
2009	42765	16435	3544	275	15	8
2010	24573	13835	3095	297	14	5
2011	35982	7468	1936	155	7	2
2012	36113	10777	996	90	3	1
2013	21247	11405	1905	77	4	1

Table 4.2.5.6.4.4. Hake in GSA 7. Summary of the a4a analysis.

	SSB (tons)	Fbar(0-3)	Rec. (thousands)
1998	1595	1.16	60733
1999	1981	1.20	47125
2000	2085	1.19	58898
2001	1882	1.30	70954
2002	1566	1.56	50152
2003	1631	1.61	30359
2004	1062	1.31	26955
2005	998	1.13	26804
2006	1497	1.26	37488
2007	1386	1.42	50362
2008	1164	1.42	49520
2009	1981	1.59	42765
2010	1245	1.99	24573
2011	854	2.06	35982
2012	701	1.70	36113
2013	781	1.34	21247

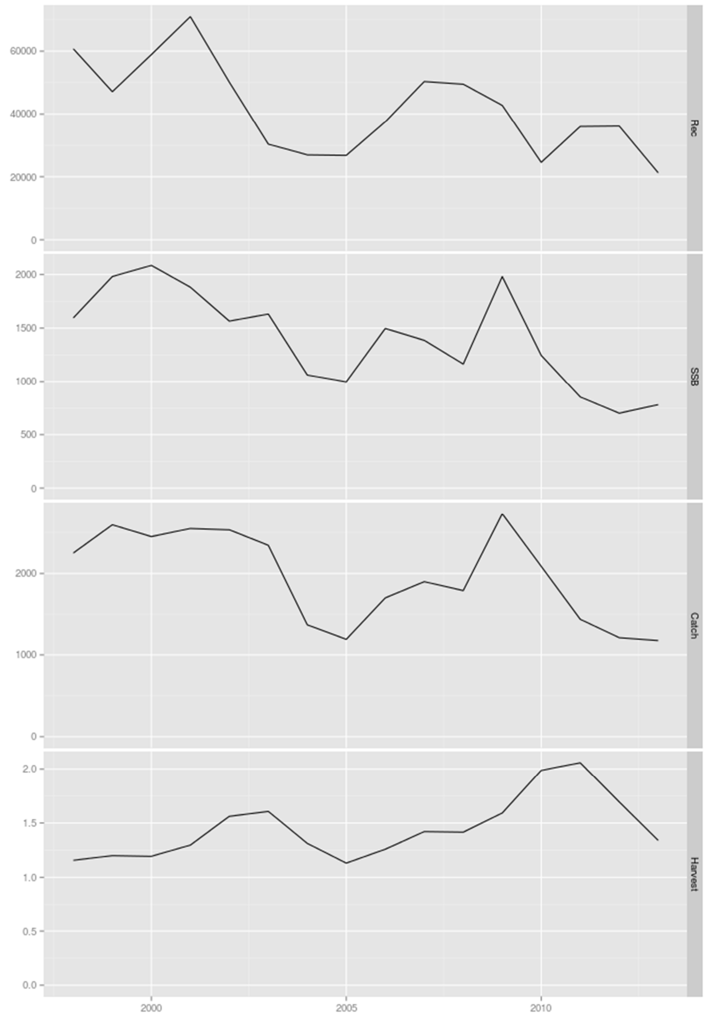


Figure 4.2.5.6.4.2. Hake in GSA 7. Time series of the estimated parameters from the a4a analysis.

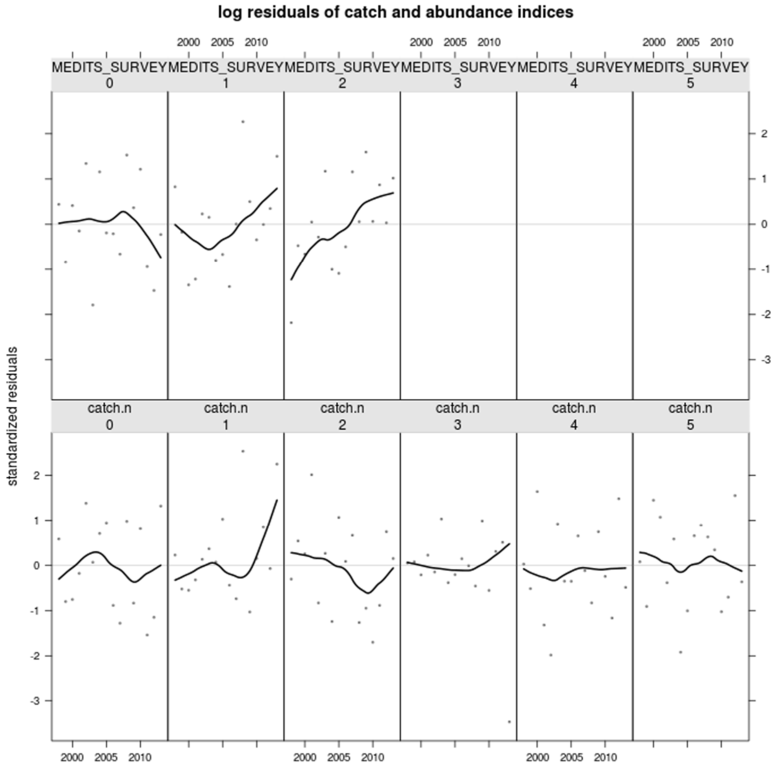


Figure 4.2.5.6.4.3. Hake in GSA 7. Residuals for the catch and MEDITS data from the a4a analysis.

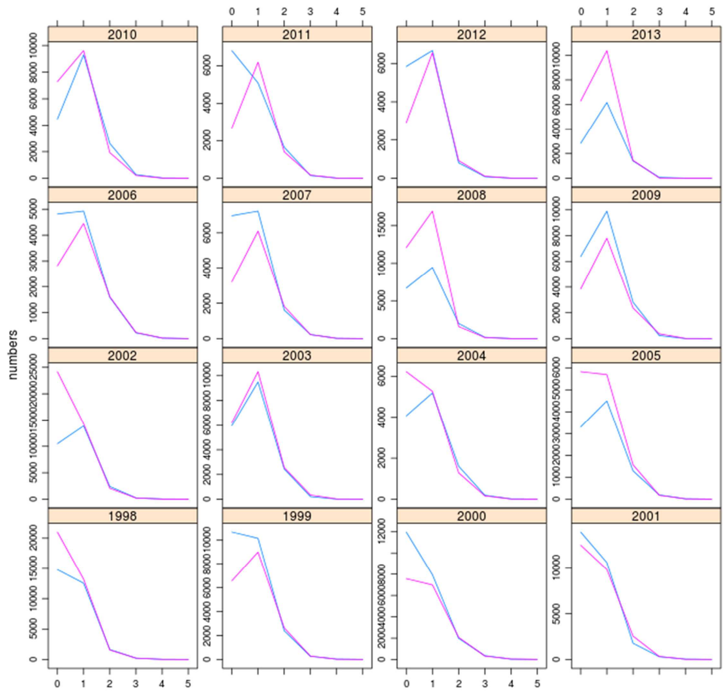


Figure 4.2.5.6.4.4. Hake in GSA 7. Predicted and observed catch by age class.

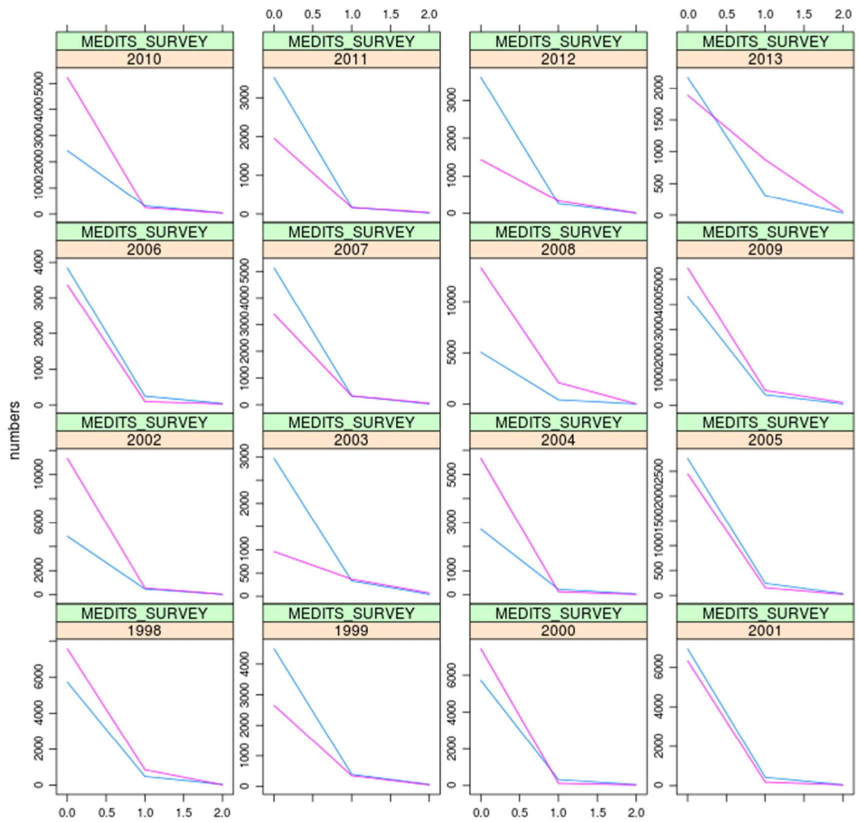


Figure 4.2.5.6.4.5. Hake in GSA 7. Predicted and observed MEDITS index by age class.

Comparison with XSA

An XSA run was performed, following the approach classically used for this model, involving sensitivity analyses on parameters to select the best run. The comparison of the a4a results with those from the XSA run displayed a good consistency as the trends for the various variables were found to be the same. The only notable differences were observed for the two last years of the fishing mortality time series, but that is likely to be linked to the well-known instability of the last years XSA estimates.

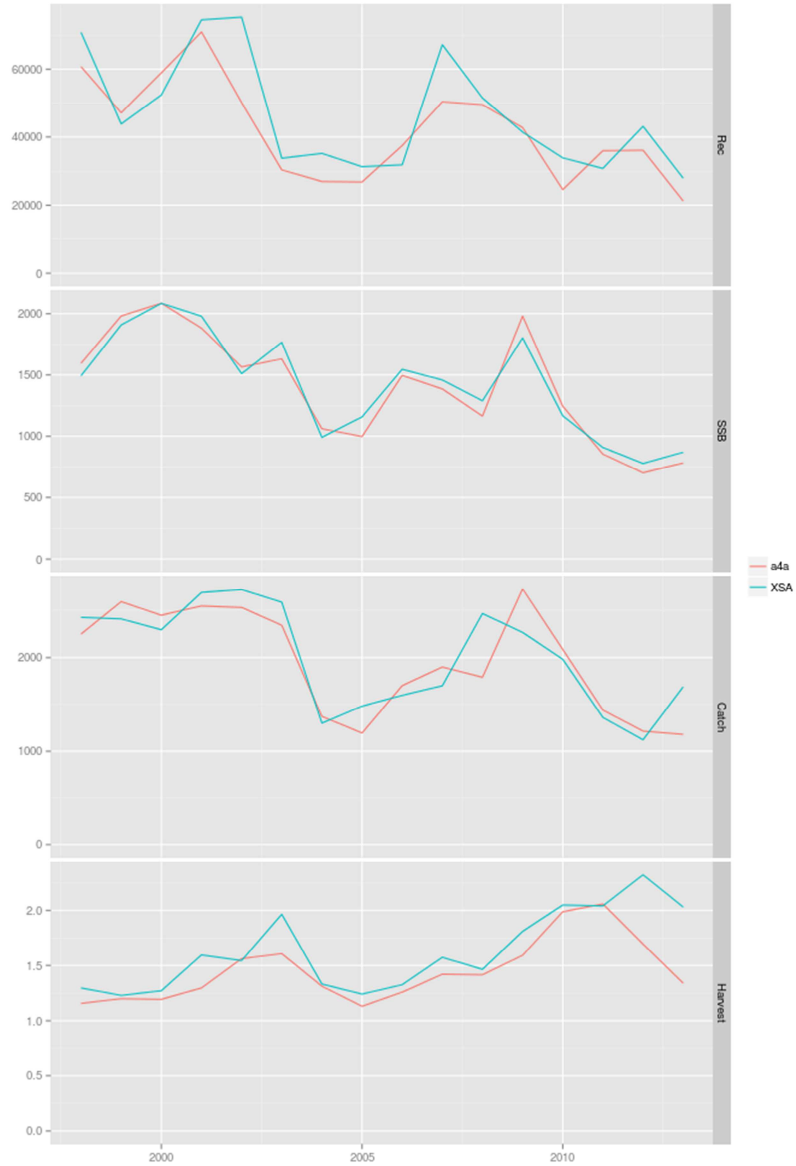


Figure 4.2.5.6.4.6. Hake in GSA 7. Comparison of the XSA and a4a run.

4.2.5.7 Long term prediction

4.2.5.7.1 Justification

As a new model was used, yield per recruit analysis was run to update the reference point (F0.1 as a proxy of FMSY).

4.2.5.7.2 Input parameters

The same population parameters used for the a4a model and exploitation pattern derived from the final model were used as input for the yield per recruit analysis.

4.2.5.7.3 Results

The reference point, F_{MSY}, was updated as a new model was used.

Table 4.2.5.7.3.1. Hake in GSA 7. Reference points

$F_{current}$	$F_{0.1}$	ratio
1.671	0.174	9.6

4.2.5.8 Data quality

All the length data was available in the database excepted effort, which was missing before 2009.

4.2.5.9 Scientific advice

After reaching very high values in 2010 and 2011, the fishing mortality seems to have initiated a decreasing trend. However, the spawning stock biomass and the recruitment are still at low levels, with little signs of improvement. The current exploitation level is well above the level estimated to be sustainable. The important decrease in capacity of the french trawler fleet since 1998, reducing the number of boats by 39%, is likely to start to have an effect on the stock and EWG 14-09 recommends to pursue in that direction so that this trend could be confirmed.

4.2.5.10 Short term considerations

4.2.5.10.1 State of the stock size

The SSB shows a decreasing trend over the analyzed period. Since the older individuals, older than age 3, are not fished and very poorly sampled by the MEDITS survey, the SSB level can not be estimated with high confidence. In the absence of a precautionary reference point the STECF EWG 14-09 was unable to fully evaluate the stock size status.

4.2.5.10.2 State of recruitment

The highest recruitment values observed over the period are in 1998, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and is currently at a low level.

4.2.5.10.3 State of exploitation

The exploitation level is currently above the level estimated to be sustainable. The reference point F_{MSY} is equal to 0.17. The current fishing mortality F_{curr} equal to 1.67 is higher than the reference point. The exploitation is mainly concentrated on younger individuals.

4.2.5.11 Management recommendations

This stock is in an overexploitation status. After reaching very high values in 2010 and 2011, the fishing mortality seems to have initiated a decreasing trend. However, the spawning stock biomass and the recruitment are still at low levels, with little signs of improvement. The current exploitation level is well above the level estimated to be sustainable. The important decrease in capacity of the french trawler fleet since 1998, reducing the number of boats by 39%, is likely to start to have an effect on the stock and EWG 14-09 recommends to pursue in that direction so that this trend could be confirmed. EWG 14-09 also recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.6 STOCK ASSESSMENT OF RED MULLET IN GSA 7

4.2.6.1 Stock Identification

Red mullet (*Mullus barbatus*) in the Gulf of Lions (GSA 7) is a shared stock exploited by both Spanish trawlers and French trawlers, also since very recent years by french gillnetters (2011 and 2013). The Gulf of Lions (GSA 7) is used as an individualized area for the assessment and management of red mullet in the western Mediterranean.

4.2.6.2 Growth

The growth of red mullet (*Mullus barbatus*) in the Gulf of Lions was estimated with Von Bertalanffy growth curve (DCF) for the beginning of the data series (2004-2011) and then age length key (DCF) for the last two years (2012, 2013). Von Bertalanffy parameters used are indicated in table 4.2.6.2.1

Table 4.2.6.2.1. Red mullet in GSA 7. Von bertalanffy parameters.

Von bertalanffy	Combined
L_{inf} (cm)	29
K (years-1)	0.25
t_0	-1.28

4.2.6.3 Maturity

The maturity was calculated using data collected within the DCF.

Table 4.2.6.3.1. Red mullet in GSA 7. Maturity at age.

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.67	0.64	0.69	0.69	0.67	0.64	0.62	0.62	0.63	0.61
1	0.84	0.85	0.83	0.84	0.86	0.85	0.85	0.86	0.84	0.85
2	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.95	0.95
3	0.97	0.98	0.97	0.98	0.97	0.97	0.97	0.97	0.97	0.97
4	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

4.2.6.4 Fisheries

4.2.6.4.1 General description of Fisheries

In the Gulf of Lions (GSA 7), red mullet is exploited by both french and spanish trawlers. Information on french gillnetters is only available for 2011 and 2013, but although it is suspected that they have been fishing red mullet in the past, no data is available to quantify their catches. Between 2004 and 2013, around 100 boats have been involved in the fishery. According to official statistics, during this period the total annual landings have oscillated around an average value of 200 tons and the french trawlers have been dominating the fishery, as they represent 83% of the catches (165 tons) on the period. Between 2010 and 2013 the number of trawlers decreased by 20% and it decreased by

50% over the 2004-2013 period. From a maximum number of 123 trawlers in 2004, the french fleet is nowadays composed by 61 units. This follows management measures to reduce the number of boats. The mean modal lengths in the catches of the french and spanish trawlers were 13.9 and 14.9 cm, respectively and the length at first capture is about 7 cm. Catch is mainly composed by individuals of age 0, 1 and 2, while the oldest age class (4+ group) is poorly represented. In GSA 07, the trawl fishery is a multi-specific fishery. In addition to *M. barbatus*, the following species can be considered important by-catches: *Merluccius merluccius, Lophius sp., Pagellus sp., Trachurus sp., Mullus surmuletus, Octopus vulgaris, Eledone sp., Scyliorhinus canicula, Trachinus sp., Triglidae, Scorpaena sp.*

4.2.6.4.2 Management regulations applicable in 2013

French trawlers

- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: not observed
- Cod-end mesh size (bottom trawl: square 40 mm or 50 mm diamond with derogation): not fully observed
- Fishing forbidden within 3 miles (France): not fully observed

Spanish trawlers

- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: not observed
- Mesh size in the codend (square 40 mm or 50 mm diamond with derogation): fully observed
- Fishing forbidden <50 m depth: fully observed
- Time at sea: fully observed

In 2009, the GFCM proposed to create a High Sea Fishery Restricted Area (FRA, GFCM/33/2009/1) in which the fishing effort for demersal stocks of vessels using towed nets, bottom and mid-water longlines, bottom-set nets shall not exceed the level of fishing effort applied in 2008 in the fisheries restricted area of the eastern Gulf of Lions. The FRA area is bounded by lines joining the following geographic coordinates: 42°40'N, 4°20' E; 42°40'N, 5°00' E; 43°00'N, 4°20' E; 43°00'N, 5°00' E. This fisheries restricted area was established in article 4 from the EU Regulation No. 1343/2011 of the European Parliament and of the Council of 13 December 2011. In 2012 both french (Arrêté du 28 décembre 2012, NOR: TRAM1240493A) and spanish (Orden AAA/1857/2012 de 22 de agosto) governments published their own laws regulating the FRA. A temporary closure of 1 month by year for the french trawlers has been enforced in 2011.

4.2.6.4.3 Catches

Total catch increase on the period with the higher levels of catch in the very recent years (Figure 4.2.6.4.3.1.). After 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species, this can explain the high catches of 2010.

Information on french gillnetters is only available for 2011 and 2013, but although it is suspected that they have been fishing red mullet in the past, no data is available to quantify their catches. Catch at age structure is stable over time, with mostly age 0-2 targeted (Figure 4.2.6.4.3.2.).

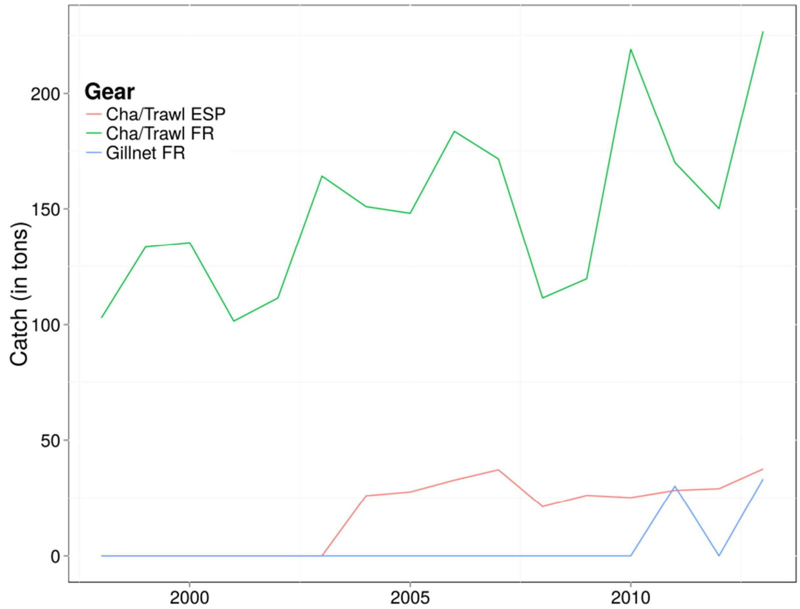


Figure 4.2.6.4.3.1. Red mullet in GSA 7. Catch by gear in tons (2004-2013).

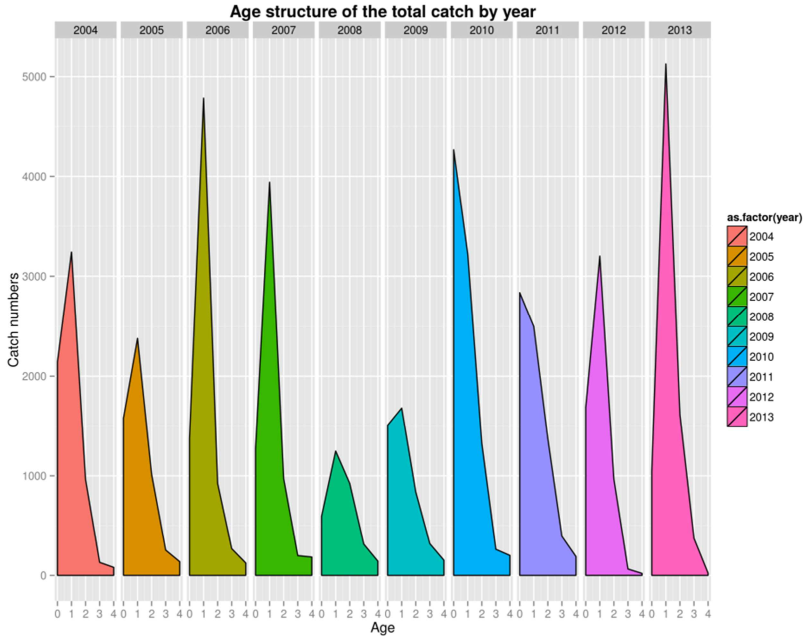


Figure 4.2.6.4.3.2. Red mullet in GSA 7. Total catch by age in tons (2004-2013).

Table 4.2.6.4.3.1. Red mullet in GSA 7. Annual catches (t) by gear (DCF data).

Gears/Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	151	148	183	172	111	120	219	170	150	227
OTB-Spanish	26	28	33	37	21	26	25	28	29	38
GNS-French	-	-	-	-	-	-	-	30	-	33

4.2.6.4.4 Landings

Table 4.2.6.4.4.1. Red mullet in GSA 7. Annual landings (t) by gear (DCF data).

Gears/Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	151	148	183	172	111	120	219	170	135.3	210.5
OTB-Spanish	26	28	33	37	21	26	25	28	29	38
GNS-French	-	-	-	-	-	-	-	30	-	33

4.2.6.4.5 Discards

No discards were observed before 2011 in France. Considering Spain, landings are almost equal to catches.

Table 4.2.6.4.5.1. Red mullet in GSA 7. Annual landings (t) by gear (DCF data)

Gears/Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	-	-	-	-	-	-	-	-	14.8	16.3
OTB-Spanish	-	-	-	-	-	-	-	-	-	-
GNS-French	-	-	-	-	-	-	-	-	-	-

4.2.6.4.6 Fishing Effort

For France, fishing effort data was provided on a yearly basis for OTB, OTM and GNS over the period 2012-2013. No data was available for the period 2002-2011. For Spain, fishing effort was provided for OTB over 2002-2012.

Table 4.2.6.4.6.1. Fishing effort (kW·days) by gear for France and Spain, 2002-2013.

GNS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB-French	-	-	-	-	-	-	-	-	-	-		3121214
OTB-Spanish	1493537	1355499	1243124	1223685	1379150	1535408	1601404	1623651	1456054	1630298	1339565	1302803
GNS-French	-	-	-	-	-	-	-	-	-	-	3081607	30200
GTR-French	-	-	-	-	-	-	-	-	-	-	2908493	30507

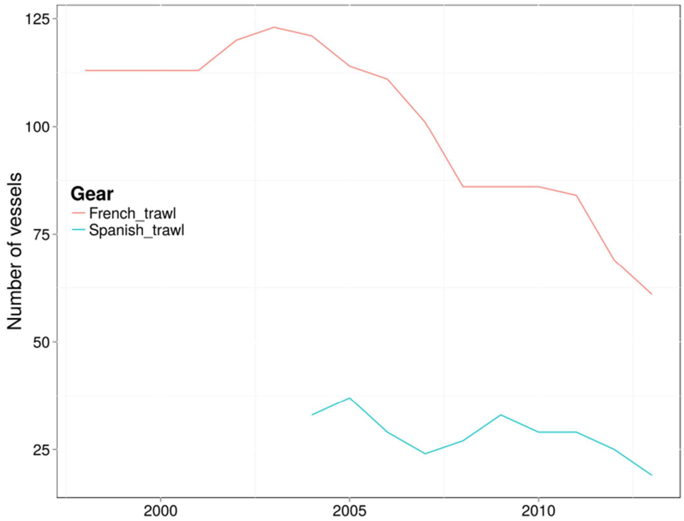


Figure 4.2.6.4.6.1. Time series of the number of French and Spanish trawlers operating in GSA 7 over the period 1998-2013

4.2.6.5 Scientific surveys

4.2.6.5.1 Methods

Fishery independent information regarding the state of the red mullet in GSA 07 was derived from the international survey MEDITS.

The data was assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This involves weighting the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions were obtained by the sum of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the GSA strata.

4.2.6.5.2 Geographical distribution

No specific analyses were conducted during EWG 14-09.

4.2.6.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 7 was derived from the international survey MEDITS. Figure 4.2.6.5.3.1 displays the estimated abundance trend of red mullet in GSA 7. No information has been documented on biomass trend.

The estimated abundance shows some increasing trend in the very recent years and folloxs the same trend as the fishery.

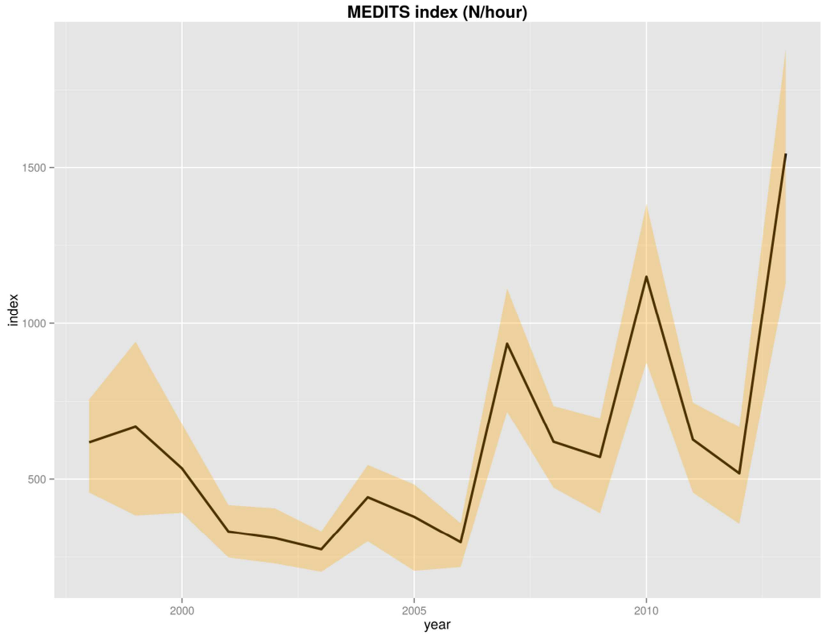


Figure 4.2.6.5.3.1. Red mullet in GSA 7. MEDITS abundance indices.

4.2.6.5.4 Trends in abundance by length or age

MEDITS targets mostly the same ages (0-2) as the fishery (Figs 4.2.6.5.4.1. - .2).

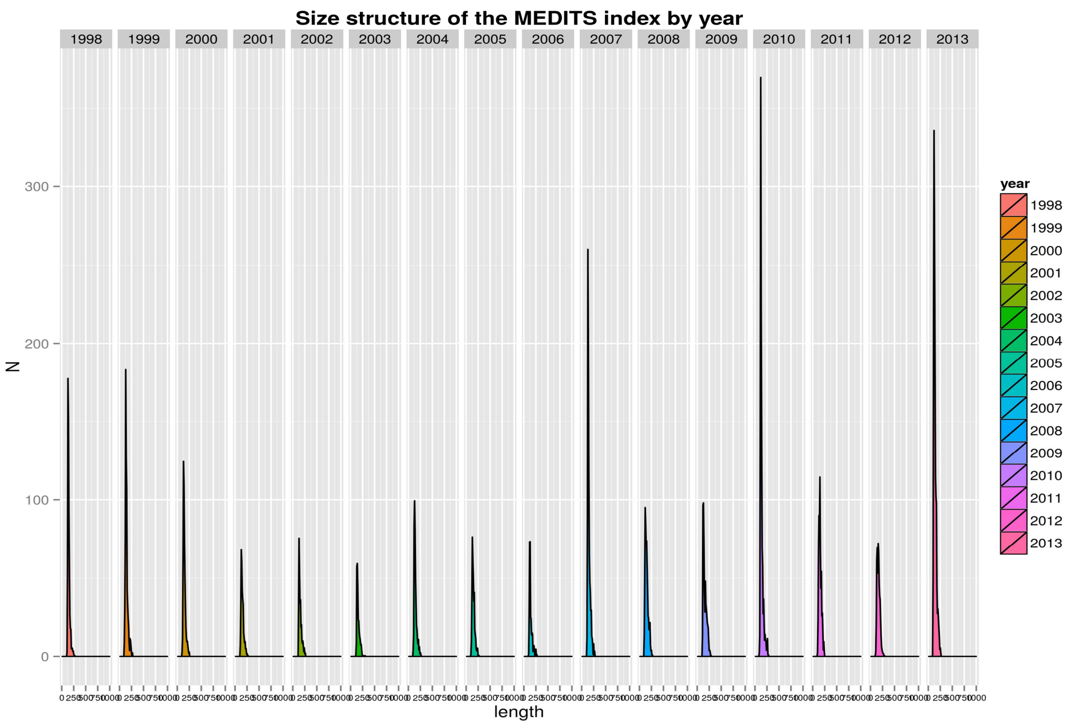


Fig. 4.2.6.5.4.1. Red mullet in GSA 7. Length frequency distribution of obtained from MEDITS survey.

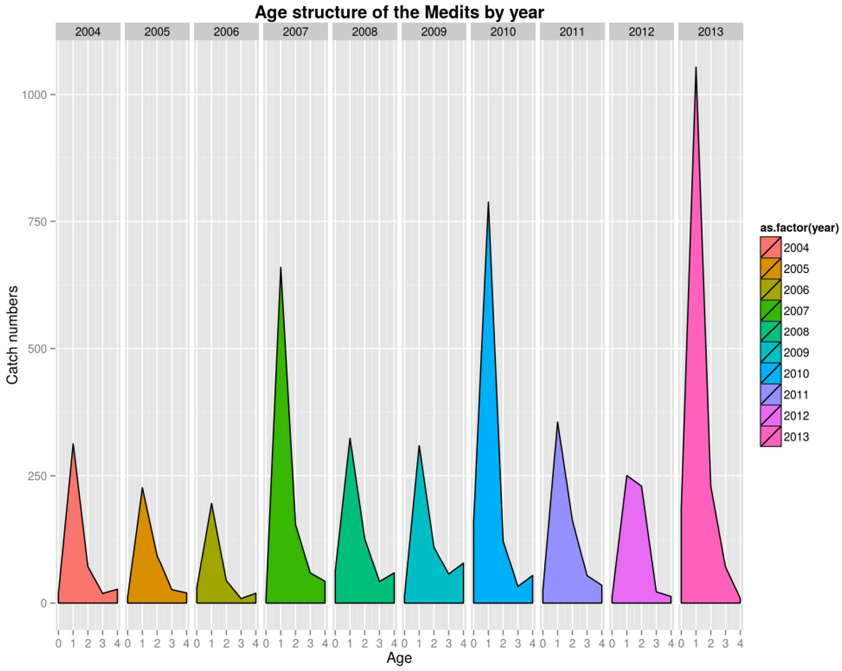


Fig. 4.2.6.5.4.2. Red mullet in GSA 7. Catch in number obtained from MEDITS survey.

4.2.6.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.6.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.6.6 Assessment of historic stock parameters

4.2.6.6.1 Method: XSA

4.2.6.6.1.1 Justification

During EWG 14-09 an assessment was made (using XSA tuned using MEDITS survey data) for the period 2004-2012. XSA was run considering age classes from 0 to 4+.

4.2.6.6.1.2 Input parameters

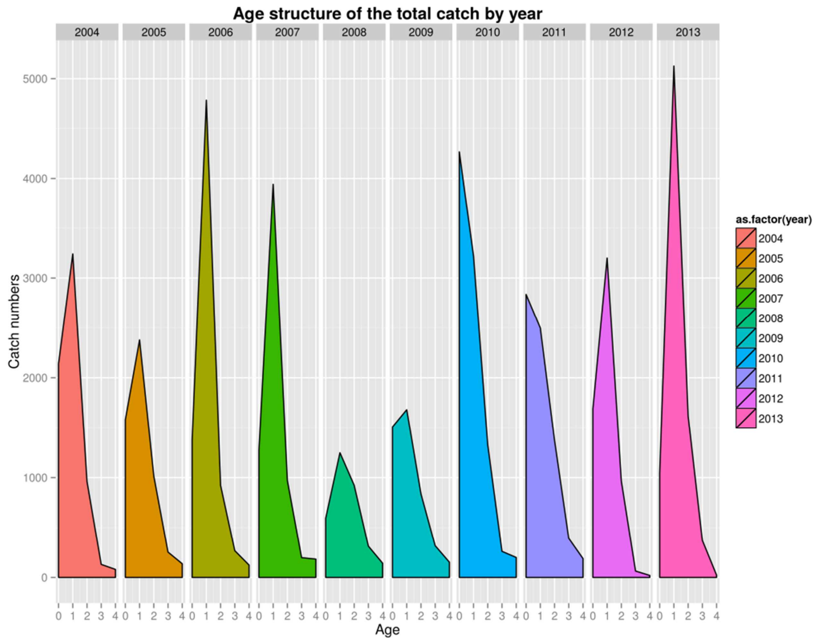


Fig. 4.2.6.6.1.2.1. Red mullet in GSA 7. Age structure of the total catch (2004-2013).

Red mullet GSA 7. Catch at Age (thousands).

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	2141	1581	1376	1274	595	1509	4266	2836	1688	1045
1	3242	2378	4781	3943	1248	1681	3222	2496	3201	5126
2	961	1016	923	970	924	838	1327	1371	965	1618
3	130	253	267	198	312	317	261	391	64	370
4+	80	137	124	183	142	152	199	188	20	23

Red mullet in GSA 7. Weight at Age (kg)

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.012	0.011	0.013	0.013	0.012	0.010	0.010	0.010	0.014	0.018
1	0.026	0.027	0.024	0.027	0.029	0.027	0.028	0.029	0.031	0.028
2	0.050	0.053	0.052	0.052	0.053	0.052	0.051	0.054	0.053	0.064
3	0.080	0.083	0.079	0.083	0.081	0.078	0.082	0.082	0.069	0.081
4+	0.116	0.138	0.111	0.112	0.112	0.107	0.118	0.121	0.132	0.093

Red mullet in GSA 7. Natural mortality (M) at age (PROBIOM)

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
1	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
2	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
3	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
4+	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Red mullet in GSA 7. MEDITS index (2004-2013).

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	18	11	30	11	62	13	160	25	12	186
1	313	227	196	660	325	310	789	356	251	1054
2	71	94	44	155	127	110	122	163	230	230
3	19	26	9	59	42	57	32	54	22	71
4+	27	20	19	43	59	78	54	35	13	9

4.2.6.6.1.3 Results

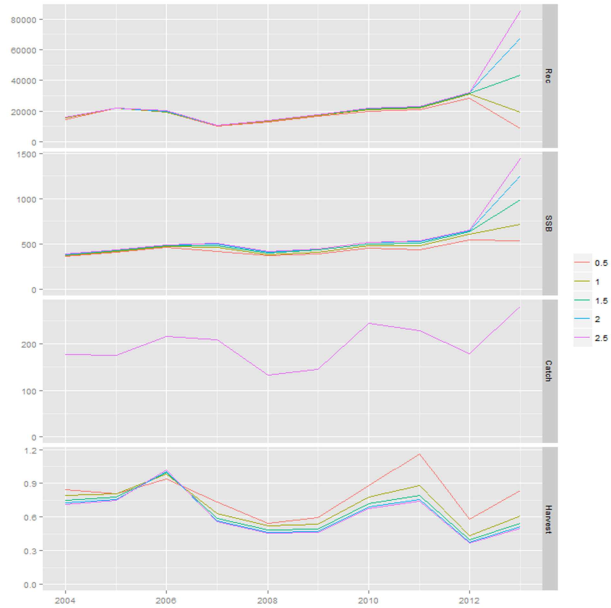
The selection of the suitable parameters for the final XSA run was performed runing four sensitivity analysis. The resulting time series SSB, fishing mortality and recruitment were plotted, (Figure 4.2.6.6.1.3.1.a-d).

The first sensitivity analysis (a) was conducted using 5 different shrinkage weight assumptions (i.e. fse 0.5, 1, 1.5, 2 and 2.5). The final setting selected is an intermediate value (1.5), similar to last year assessment.

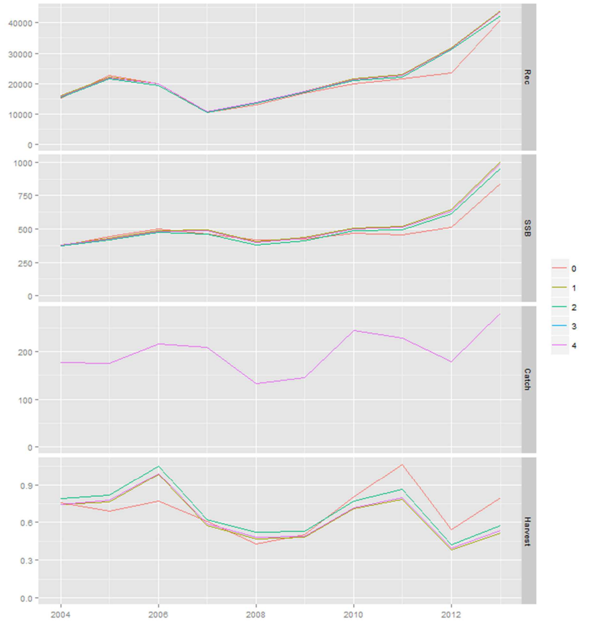
The second analysis (b) was conducted to assess the effect of the age after which catchability is no longer estimated (i.e. qage assigning values ranging from 0 to 4). The final setting selected is a constant catchability for all ages, similar to last year assessment.

The third analysis (c) was conducted to assess the effect of shrinkage on the last ages (i.e. ranging from 0 to 4). The final setting selected is a shrinkage on the last 3 ages, similar to last year assessment.

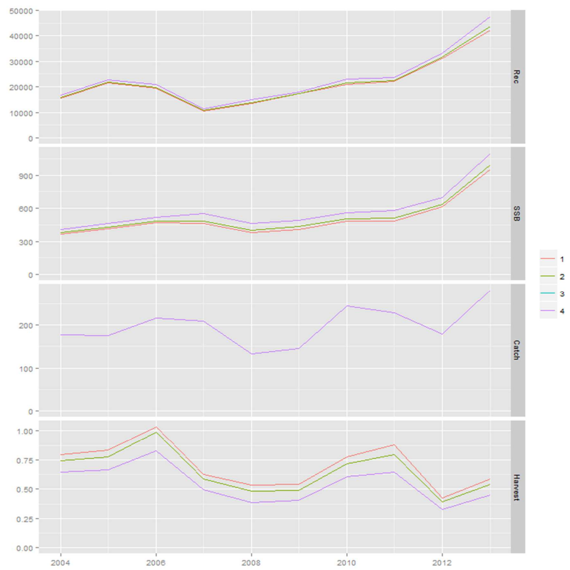
The fourth analysis (d) was conducted to assess the effect of shrinkage on the last years (i.e. ranging from 1 to 5. The final setting selected is a shrinkage on the last 4 years, similar to last year assessment. The parameters finally retained for the final run are in Table 4.2.6.6.1.3.1.



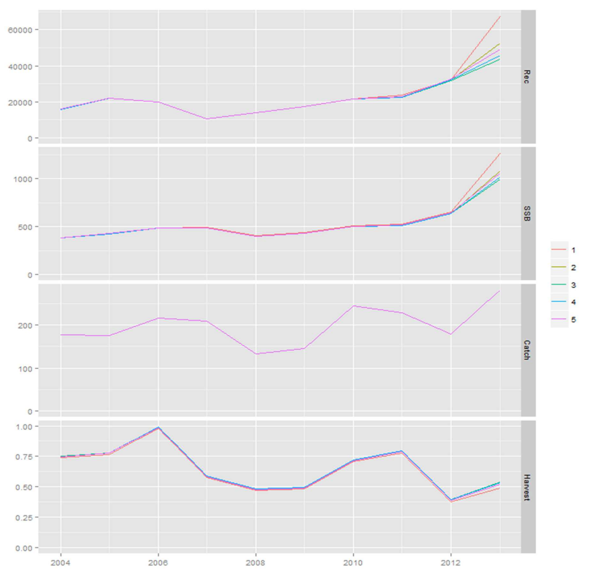
a) Shrinkage weight (i.e. fse 0.5, 1, 1.5, 2 and 2.5)



b) Catchability (qage values ranging from 0 to 4)



c) Shrinkage on the last ages (i.e. ranging from 0 to 4)



d) Shrinkage on the last years, (i.e. ranging from 1 to 5)

Figure 4.2.6.6.1.3.1. Red mullet in GSA 7. Sensitivity analysis on shrinkage weight (a), catchability (b), shrinkage on the last ages (c) and years (d)

Table 4.2.6.6.1.3.1. Red mullet in GSA 7. XSA settings.

Fse	shk.yrs	shk.ages	rage	qage
1.5	4	3	-1	4

Moreover a retrospective analysis was conducted on recruitement, mean F and SSB (Figure 4.2.6.6.1.3.5) to ensure the robustness of the final estimates. The model shows some instablility linked to the high recruitment of the last year, moreover 60% of age 0 is SSB.

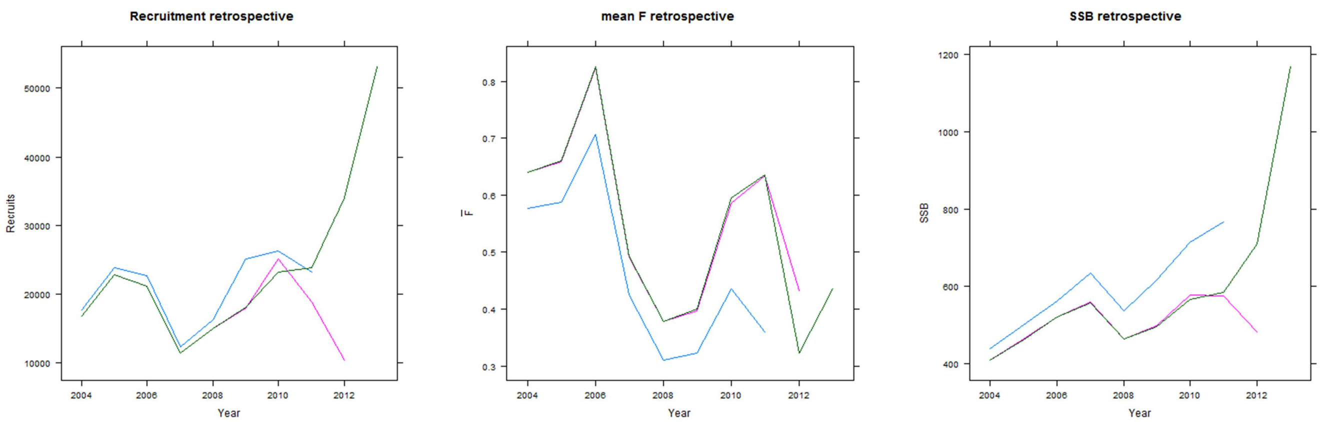


Figure 4.2.6.6.1.3.2. Red mullet in GSA 7. Retrospective analysis (Recruitement, mean F and SSB).

The results of the assessement (Figure 4.2.6.6.1.3.3.) show some increase in recruits in the very recent years and also on spawning stock biomass (SSB) since 60% of age 0 is SSB. Very recent fishing mortalities are the lowest observed over the period. MEDITS log residuals (fig. 4.2.6.6.1.3.4.) are quite low and no trend can be observed.

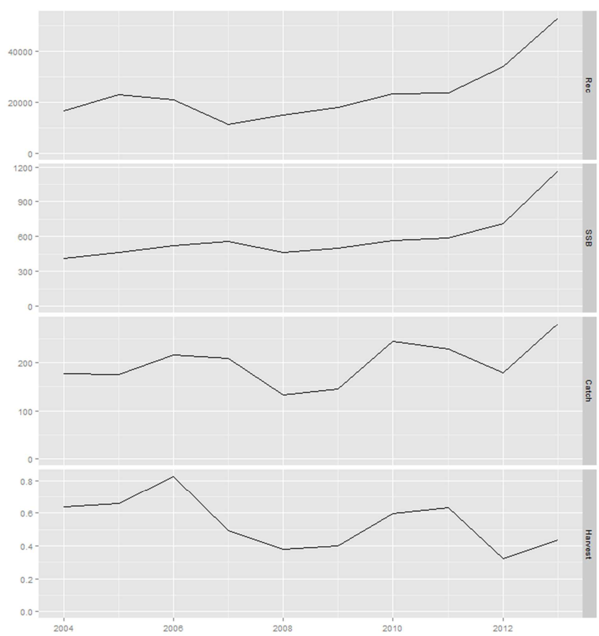


Figure 4.2.6.6.1.3.3. Red mullet in GSA 7. XSA results: Recruitment, SSB, Catch and F.

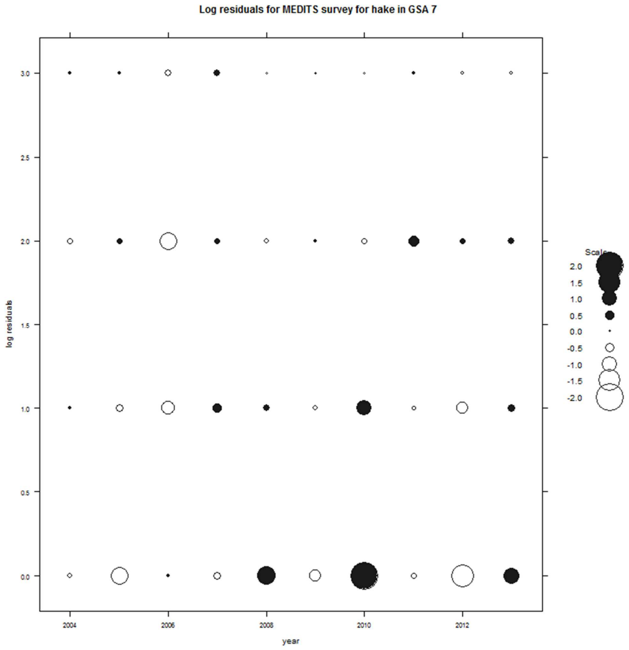


Figure 4.2.6.6.1.3.4. Red mullet in GSA 7. Log catchability residual plots (XSA) for the tuning fleet, MEDITS

4.2.6.6.2 Method: a4a

4.2.6.6.2.1 Justification

We used the 'a4a' framework to run a variety of statistical catch at age models and compared the results to XSA.

4.2.6.6.2.2 Input parameters

Input parameters are the same as those used for the XSA model for biological parameters, catch and abundance indices. The a4a statistical catch at age model requires to define a catchability model, a fishing mortality model, a stock-recruitment model, and a variance model. Table 4.2.6.6.2.2.1 summarizes the different types of models used. The stock-recruitment model was assumed to be year-dependent. We run all possible combinations of these model formulations which resulted in 1759 potential models.

Table 4.2.6.6.2.2.1. Red mullet in GSA 7. Description of the different models used for the fishing mortality (fmodels), the catchability models (qmodels), and the variance models (vmodels) for the statistical catch at age ('a4aSCA' function in the a4a R package).

fmodels	qmodels	vmodels
~list(s(age; k = k1))	~factor (year) + factor (age)	~list(~1; ~1)
~list(factor (age))	~s(year ; k = k1)	~list(s(year ; k = k5)
~s(age; k = k1)	~list(s(year ; k = k5) + s(age; k = k6); s(year ; k = k7) + s(age; k = k8))	
~te(year ; age; k = c(k3; k4))	~list(~s(year ; k = k5); ~1)	
~s(year ; k = k1) + s(age; k = k2)	~list(~s(age; k = k5; by = breakpts(year ; 2012)); ~1)	
~s(year ; k = k1) + factor (age)	~list(~s(year ; k = k5) + s(age; k = k6); ~1)	
~factor (year) + s(age; k = k2)	~list(~s(age; k = k5); ~1)	
~s(year ; k = k1) + s(age; k = k2) +te(year ; age; k = c(k3; k4))	~list(~s(year ; k = k5); ~s(year ; k = k6))	
~factor (year) + factor (age) +te(year ; age; k = c(k3; k4))		
~s(year ; k = k1) + factor (age) +te(year ; age; k = c(k3; k4))		
~factor (year) + s(age; k = k2) +te(year ; age; k = c(k3; k4))		
~I (1=(1 + exp(age))) + s(year ; k = k1)		
~I (1=(1 + exp(age))) + s(age; k = k2)		
~I (1=(1 + exp(age)))+te(year ; age; k = c(k3; k4))		

4.2.6.6.2.3 Results

Over the 1759 potential models, 959 models converged (54%). We assessed the quality of the model fits using 2 types of criteria: lowest AIC/BIC, lowest square error between catch estimates and landings and model residuals (lowest interquartile range, and median value closest to 0). Each model was then ranked according to these criteria. We performed a Principal Component Analysis (PCA) on the ranking (Fig. 4.2.6.6.2.3.1) to compare the quality of the different fits. The PCA showed models with lowest AIC/BIC and lowest square error between catch estimates are not the one have the best residuals.

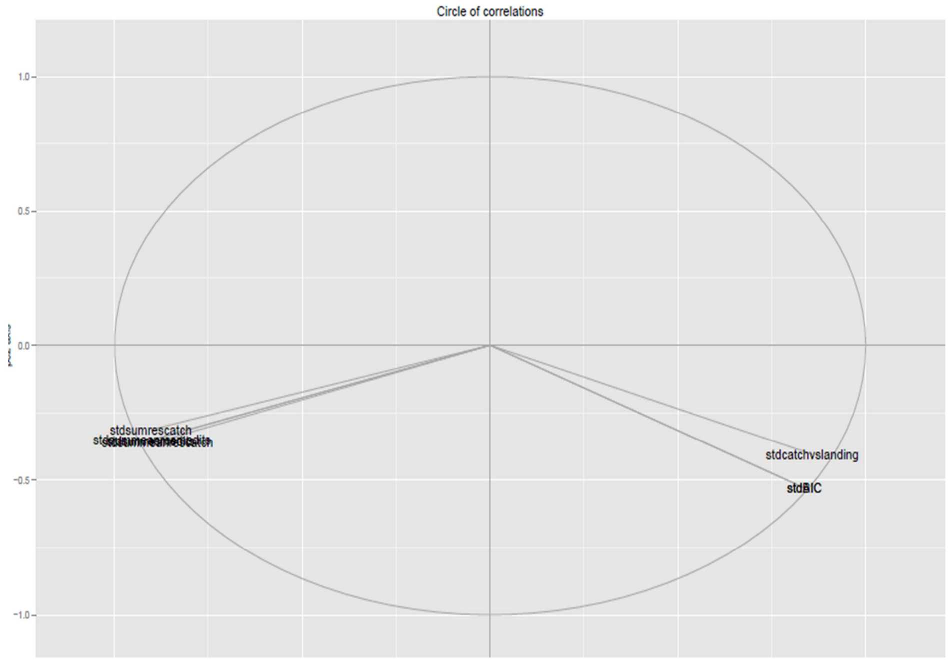


Figure 4.2.6.6.2.3.1. Principal Component Analysis of the quality ranking based on AIC/BIC, square error between catch estimates and landings, and residuals analysis.

We then selected the 5 'best' models which had the lowest AIC/BIC, the lowest square error between estimated catch and landings, and the best residuals. We compare the outputs of these 5 models to XSA results (Fig. 4.2.6.6.2.3.2).

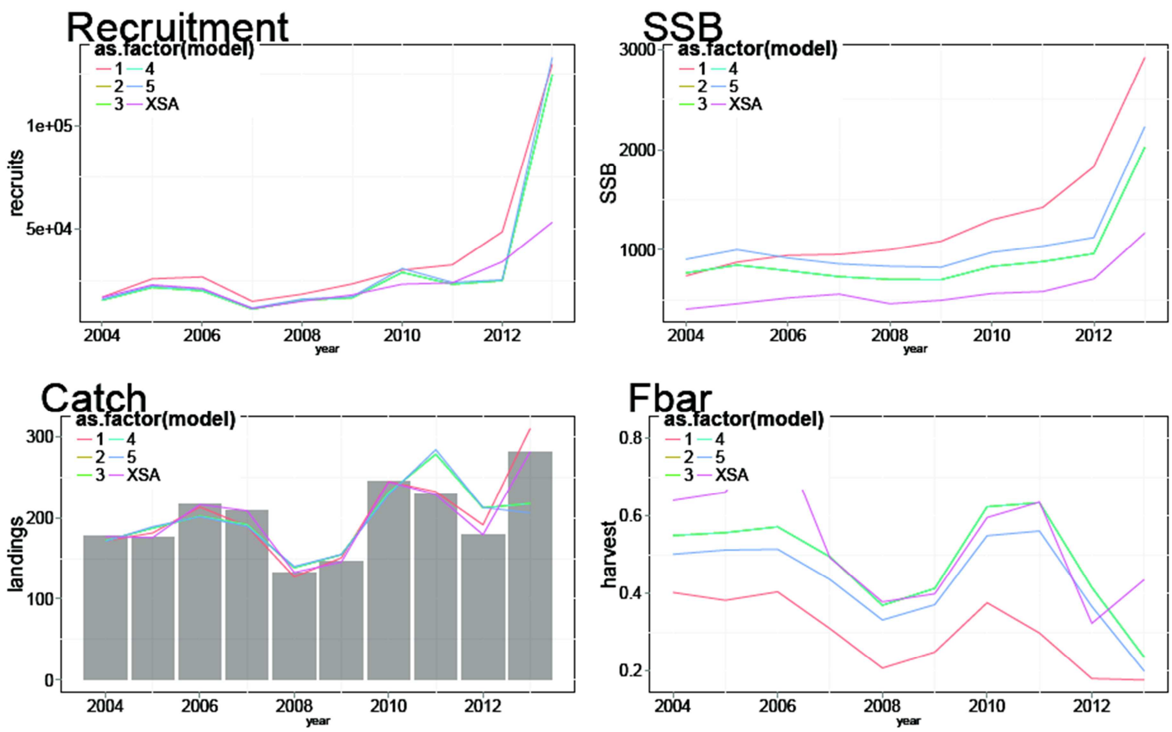


Figure 4.2.6.6.2.3.2. Red mullet in GSA 7. Outputs of the 5 best models and XSA for recruitment, spawning stock biomass, catch, and fishing mortality estimates.

The five 'best' models have very similar results in terms of recruitment, spawning stock biomass, catch, and fishing mortality estimates. Residuals patterns of these models were generally good with no extreme values. These 'best' models gave results similar to XSA in terms of catch and fishing mortality but they gave higher estimates of recruitment and spawning stock biomass.

This general framework of testing a large number of models showed interesting potential to objectively assess this stock and test different hypotheses for biological parameters, catch and abundance indices data, and model specifications. This would require further work and XSA was finally kept as the base-case model for the red mullet stock assessment.

4.2.6.7 Long term prediction

4.2.6.7.1 Justification

Yield per recruit analysis was used (FLBRP) to calculate the reference point ($F_{0.1}$ as a proxy of F_{MSY}) and the estimated reference fishing mortality ($F_{current}$).

4.2.6.7.2 Input parameters

The referent F was estimated using the default assumptions agreed in the meeting, e.g., weights are means of the last 3 years and future recruitment is the geometric mean of the last 3 years.

4.2.6.7.3 Results

Table 4.2.6.7.3.1. Red mullet in GSA 7. Reference points

Assessement reference	Fcurrent	F0.1	ratio
2013	$F_{(2010\text{-}2012)}$= 0.56	0.14 (estimated in 2012)	4.00
2014	$F_{(2011\text{-}2013)}$= 0.45	0.20 (estimated in 2013)	2.25
2014	$F_{(2011\text{-}2013)}$= 0.46	0.14 (estimated in 2012)	3.21

The group agreed not to reestimate the reference point this year. Final results were $F_{0.1}$=0.14 (estimated in 2012), $F_{current\ (2011\text{-}2013)}$ = 0.45, (ratio $F_{current\ (2011\text{-}2013)}/F_{0.1}$= 3.21).

4.2.6.8 Data quality

All lengths informations were available through the database. Effort data was missing before 2009.

4.2.6.9 Scientific advice

The fishing mortality seems to have initiated a decreasing trend and the spawning stock biomass and the recruitment are increasing. The important decrease in capacity of the french trawler fleet since 1998, reducing the number of boats by 39%, is likely to start to have an effect on the stock.

4.2.6.10 Short term considerations

4.2.6.10.1 State of the stock size

The SSB shows an increasing trend since 2008. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.6.10.2 State of recruitment

The recruitment shows some increasing trend over the period with the highest values observed in the very recent years.

4.2.6.10.3 State of exploitation

The exploitation level is currently above the level estimated to be sustainable since the referent point F_{MSY} is equal to 0.14 and current fishing mortality ($F_{current\ (2011\text{-}2013)}$) is equal to 0.45. The exploitation is mainly concentrated on young individuals (age 0-2), moreover 60% of the recruitement (age 0) is mature.

4.2.6.11 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.7 STOCK ASSESSMENT OF HAKE IN GSA 9

4.2.7.1 Stock Identification

Due to a lack of information about the structure of hake population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries (Fig. 4.2.7.1.1)

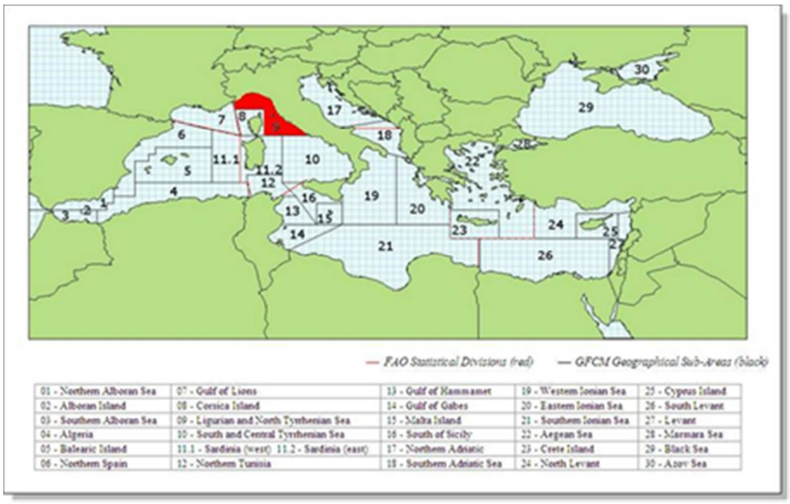


Fig. 4.2.7.1.1. Geographical location of GSA 9.

Hake is distributed in the whole area between 10 and 800 m depth (Biagi et al., 2002; Colloca et al., 2003). Recruits peak in abundance between 150 and 250 m depth over the continental shelf-break and appear to move slightly deeper when they reach 10 cm total length. Crinoid (*Leptometra phalangium*) bottoms over the shelf-break are the main settlement habitat for hake in the area (Colloca *et al.*, 2004, 2006; Reale *et al.*, 2005). Migration from nurseries takes place when juveniles attained a critical size between 13 and 15.5 cm TL (Bartolino et al., 2008a). Maturing hakes (15-35 cm TL) persist on the continental shelf with a preference for water of 70-100 m depth, while larger hakes can be found in a larger depth range from the shelf to the upper slope. Juveniles show a patchy distribution with some main density hot spots (i.e. nurseries areas) showing a high spatio-temporal persistence (Abella *et al.*, 2005; Colloca *et al.*, 2006; 2009; Jona Lasinio *et al.*, 2007) as also highlighted by the MEDISEH project (Fig. 4.2.7.1.2) in areas with frontal systems and other oceanographic structures that can enhance larval transport and retention (Abella *et al.*, 2008).

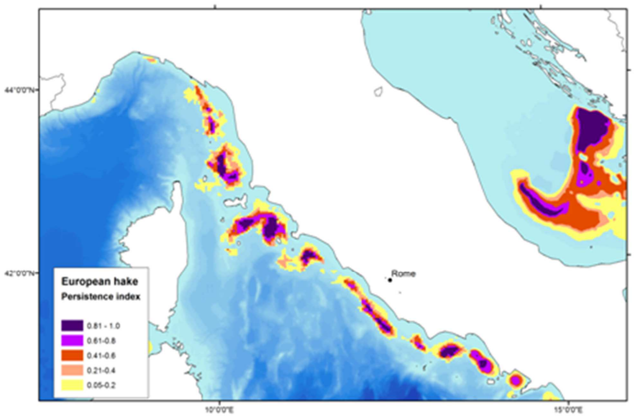


Fig 4.2.7.1.2. Temporal persistence of hake nurseries calculated from MEDITS time-series density maps (1994-2012) of recruits (Total Length<14 cm). The figure is taken from the MEDISEH project.

Although hakes are demersal fish feeding typically upon fast-moving pelagic preys while ambushed in the water column (Alheit and Pitcher, 1995), there is evidence that hakes feed in mid-water or at the surface during night-time, undertaking daily vertical migrations (Orsi-Relini *et al*., 1989, Carpentieri *et al*., 2008) which are more intense for juveniles. In GSA 09 many different studies are available on hake diet. Results from stomach data collected in the 1996-2001 period can be found in Sartor et al. (2003a) and Carpentieri et al. (2005). Hake diet shifts from euphausids and mysiids consumed by smaller hake (<16 cm TL), to fishes consumed by larger hake.

Before the transition to the complete ichthyophagous phase (TL> 36 cm) hake shows more generalized feeding habits where decapods, benthic (Gobiidae, *Callionymus* spp.,) and necktonic fish (*S. pilchardus, E. encrasicolus*) dominated the diet, whereas cephalopods had a lower incidence (Fig. 4.2.7.1.3).

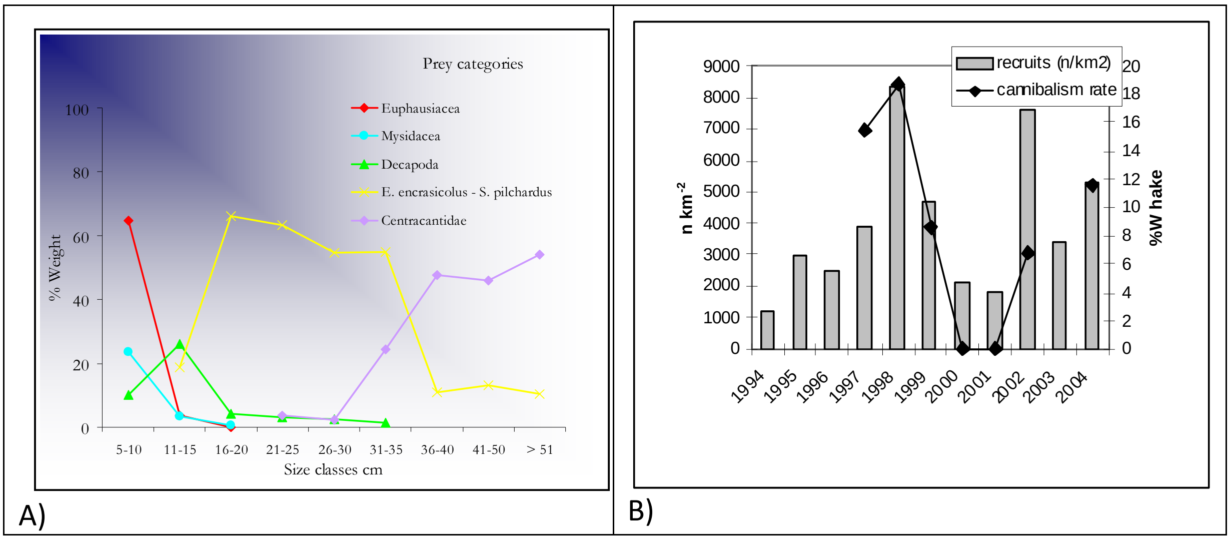


Fig. 4.2.7.1.3. A) Hake diet composition in GSA 9 by size class (from Carpentieri *et al*., 2005). B) Relationships between recruitment and cannibalism rate (proportion by weight, %W, of hake in hake stomachs.

Estimation of cannibalism rate has been provided for the southern part of the GSA (Latium, EU Because project). Cannibalism increased with size and can be considered significant for hakes between 30 and 40 cm TL (up to 20% by weight in diet) and seems to relate closely to hake recruitment density and level of spatial overlapping.

Consumption rate has been estimated for juveniles and piscivorous hakes. Daily consumption of juveniles, calculated in proportion of body weight (%BW), varied between 5 (July) and 5.9 % BW (Carpentieri et al., 2008). The estimated relative daily consumption for hake between 14 and 40 cm TL, using a bioenergetic approach (EU Because project), was between 2.9 and 2.3 BW%.

4.2.7.2 Growth

Juvenile growth rate was estimated to be about 1.5 cm.month-1 using daily growth increments on otoliths (Belcari et al., 2006). According to this growth rate, hake reaches an average length of about 18 cm TL at the end of the first year. According to these observations, the growth of hake in the GSA 9 seems to follow the pattern estimated in the NW Mediterranean (Garcia-Rodriguez and Esteban, 2002) adopting the hypothesis that two rings are laid down on otoliths each year. This new interpretation of otolith ring patterns returns a growth rate (L_{inf} = 103.9, k = 0.212, t_0 =0.031) almost double than that assumed in the past.

As showed in the Fig. 4.2.7.2.1, cohorts obtained through age slicing of LFDS MEDITS data according to fast growth parameters, can be consistently followed during time, while a less reliable pattern was obtained using parameters conform to the slow growth hypothesis.

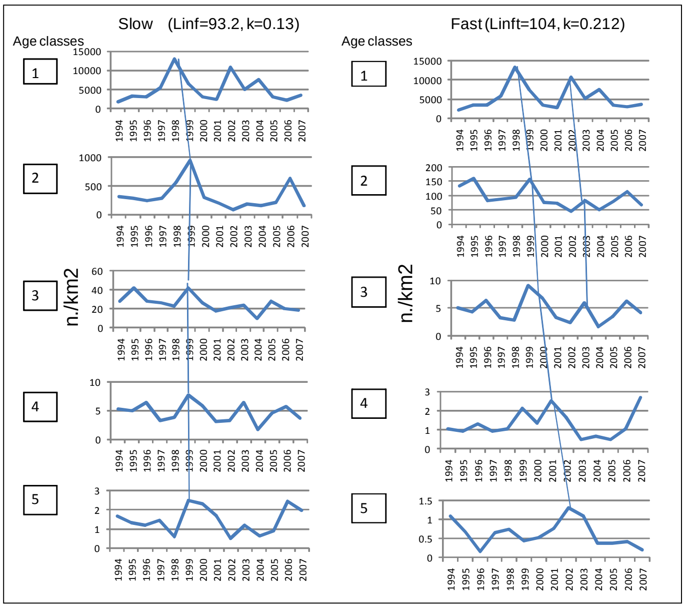


Fig. 4.2.7.2.1. Hake in GSA 9. Trends in abundance of age classes obtained using age slicing according to two different sets of growth parameters on MEDITS data.

4.2.7.3 Maturity

The catchability of hake spawners to the Mediterranean trawl nets is rather limited. The distribution of adults which are more abundant on deeper or untrawable grounds, or the ability of larger fish to avoid capture have been claimed as causes of the observed extremely reduced catch of adult hake by trawlers in the Mediterranean (Abella *et al.*, 1997). Also during trawl surveys (MEDITS and GRUND) the catch rate of mature specimens was very low, reducing the possibility of use trawl survey data to explore patterns in gonad development as well as the relationships between growth rate and maturation processes.

Large size hake are targets of a specifically targeted gillnet fishery carried out by several vessels working in the southern part (northern and central Tyrrhenian Sea) of the GSA 9 (Sartor *et al*., 2001a).

Reproductive biology and fecundity of hake have been studied in northern Tyrrhenian Sea (Biagi *et al*., 1995; Nannini *et al.*, 2001; Recasens *et al*., 2008) by monthly samplings of adults caught by trawling and gillnets.

Females in advanced maturity stages, spawning and partial post-spawning are present all year round, but reproductive activity is concentrated from January to May, with two peaks of spawning in February and May. The presence of hake spawners seems to be more concentrated in the southern part of GSA 9.

Female length at first maturity was estimated at 35 cm TL in northern Tyrrhenian Sea (Recasens *et al*., 2008). This value is consistent with the observations obtained from trawl surveys over the Latium (Colloca, pers. comm.) reporting first maturity from 31 to 37 cm TL for females and from 21 to 25 cm TL for males.

Batch fecundity was about 200 eggs per gonad-free female gram, with asynchronous oocyte development (Recasens *et al*., 2008).

4.2.7.4 Fisheries

4.2.7.4.1 General description of Fisheries

Hake is one of the main target species of bottom trawlers in the GSA 9 in terms of landings, incomes and vessels involved. The analysis of available information suggests that about 50% of landings of hake are obtained by bottom trawl vessels, the remaining fraction being provided by artisanal vessels using set nets, in particular gillnets.

The trawl fleet of GSA 9 accounted for 301 vessels in 2012 based in several ports: Viareggio, Livorno, Porto Santo Stefano, Civitavecchia, Fiumicino, Anzio, Terracina, Gaeta, Formia.They accomplish daily fishing trips exploiting both continental shelf and slope areas. Hake fishing grounds comprise all the soft bottoms of continental shelves and the upper part of continental slope. Fishing pressure shows a spatial pattern inside the GSA 9 according to the consistency of the fleets and the distance of the fishing grounds from the main ports.

The artisanal fleets, according to the last official data (2012), accounted for 1266 vessels that operate in several harbours along the continental and insular coasts. Of these, about 40 vessels, mainly located in some harbors of the GSA 9 (e.g. Marina di Campo, Ponza, Porto Santo Stefano), utilize gillnets and target medium and large-sized hakes (larger than 25 cm TL), mainly from November to May.

4.2.7.4.2 Management regulations applicable

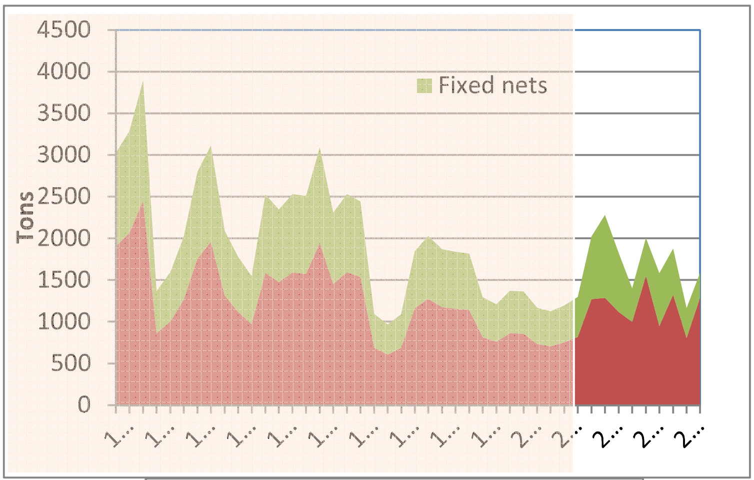
- Fishing closure for trawling: 45 days in late summer (not every year have been enforced)
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for hake.
- Cod end mesh size of trawl nets: 40 mm square meshes or 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.
- Two small No Take Zones ("Zone di Tutela Biologica", ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

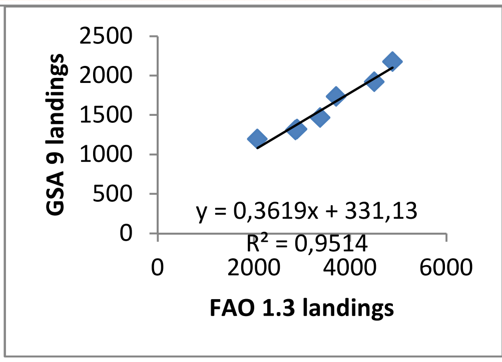
4.2.7.4.3 Catches

4.2.7.4.4 Landings

A 40 years time series of hake catches in the GSA 9 was obtained from the official FAO landings statistic for subdivision 1.3 (Fig. 4.2.7.4.4.1 a). Thes landings data were compared with the official DCF landings for the period 2004-2010 to derive a scaling factor to be applied over the entire time series (Fig. 4.2.7.4.4.1 b).
Discard data for 2006, 2008, 2012, 2013 were used to calculate proportion of discards over the landings to be applied in years without landings estimates and assuming a negligible discards before 1995. According to local experts discards practices increased consistently only after mid '90s.
In the last six years the total landings of hake of GSA 09 fluctuated between 1,195 to about 2,300 tons (Tab. 4.2.7.4.4.1).

a)





b)

Fig. 4.2.7.4.4.1. Hake in GSA 9. Trend in landings since 1970 (a). Shadow area indicate the period for which landings were reconstructed based on the relationships between hake landings in GSA 9 and FAO statistical division 1.3 (b).

The Table 4.2.7.4.4.1 lists the landings data of hake in GSA 9 coming from the Data Collection Regulation, by major gear types.

During the STECF-SGMED-10-03 was raised the issue of a poor reliable catch estimates for set nets (GNS in particular) in the period 2004-2008. In the last three years the contribution of fixed nets to the total catch appear more reliable according to knowledge of local experts in fisheries.

Table 4.2.7.4.4.1 Hake in GSA 9. Landings (t) by year and gear (GNS: gillnets, GTR: trammel nets, OTB: bottom trawlers) for the period 2006-2012.

GEAR	2006	2007	2008	2009	2010	2011	2012	2013
GNS	592.6	576.2	345.2	401.3	576.3	502.1	309.3	199.2
GTR	404.0	131.9	61.1	54.0	56.7	54.3	48.6	98.1
OTB	1180.0	1025.0	914.8	853.2	834.1	795.4	653.6	1044.3
Total	2176.5	1733.0	1321.1	1308.5	1467.1	1351.7	1011.5	1341.6

Trawl catches are traditionally dominated by small sized specimens of age classes 0+ and 1+. Gillnet fishery lands mostly 1+ and 2+ years old specimens, (Fig. 4.2.7.4.4.2).

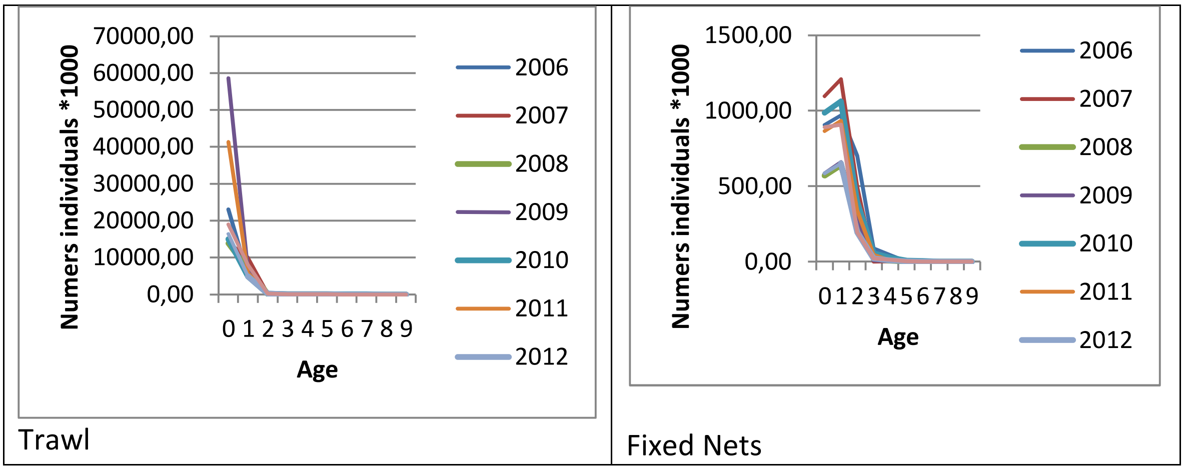


Fig. 4.2.7.4.4.2. Hake in GSA 9. Age composition of the catches of bottom trawlers and artisanal vessels using gillnets and trammel nets in the period 2006-2013.

Fig. 4.2.7.4.4.3 shows the size structure of landings from 2006 to 2013. The landing composition of fisheries exploiting hake is showed in fig. 4.2.7.4.4.4

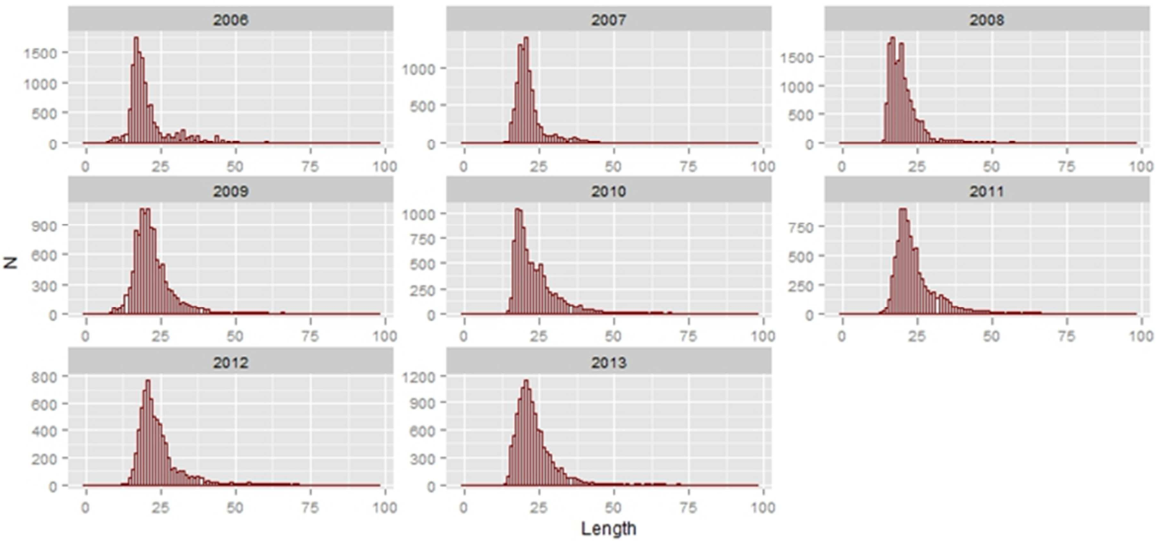
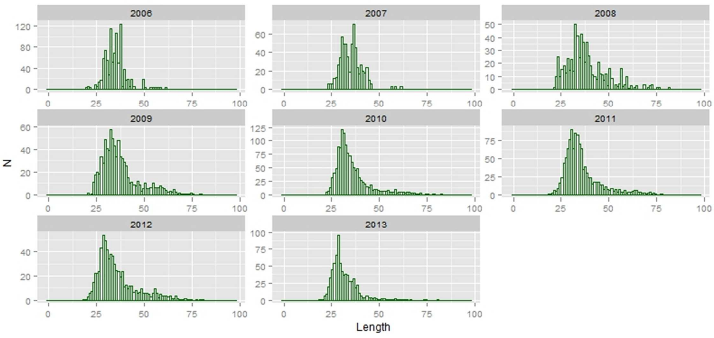
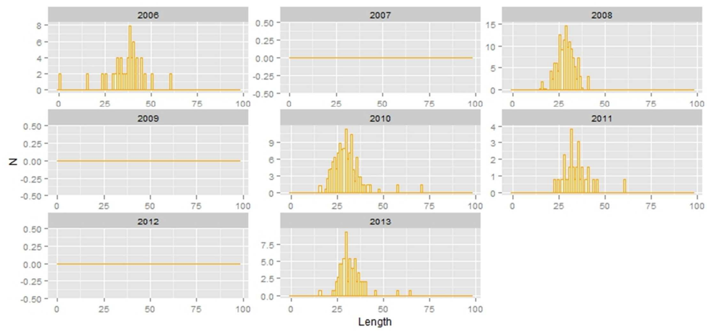


Fig. 4.2.7.4.4.3. Hake in GSA 9. Size structure of the landings from 2006 to 2013.

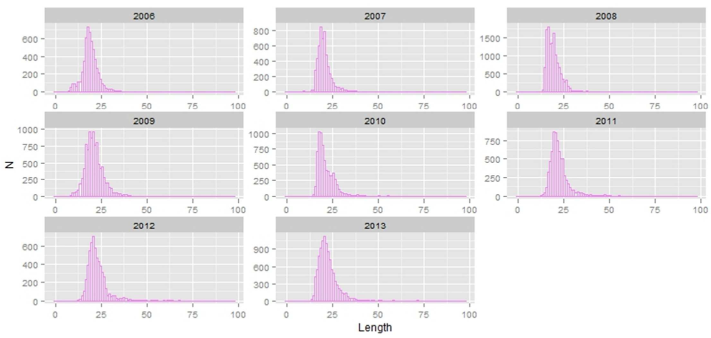
GILLNETS



TRAMMEL NETS



MIX DEMERSAL TRAWL



DEEP TRAWL

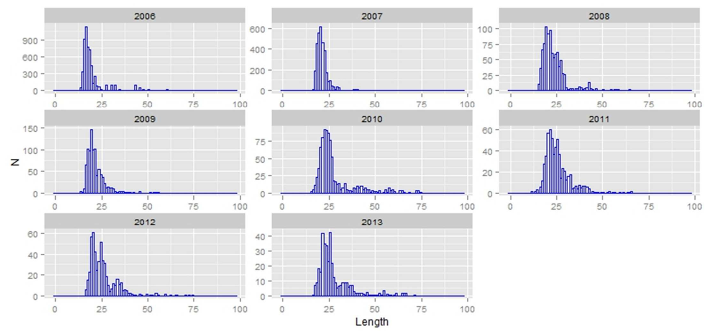


Fig. 4.2.7.4.4.4. Hake in GSA 9. Size composition of by year and fishery.

4.2.7.4.5 Discards

Several EU and national projects carried out in GSA 9 highlighted the problem of hake trawl discards. High quantities of age hake are routinely discarded, especially in summer and on the fishing grounds located near the main nursery areas (Fig. 4.2.7.4.5.1).

The size at which 50% of the specimens caught is discarded is progressively increased in the last years from about 11 cm TL in 1995 (Sartor *et al.*, 2001b) to about 17 cm TL in 2006 (De Ranieri, 2007), due to the introduction of the EU Regulations on minimum sizes.This phenomenon might be also explained by a reduction of the fishing pressure on the nursery areas.

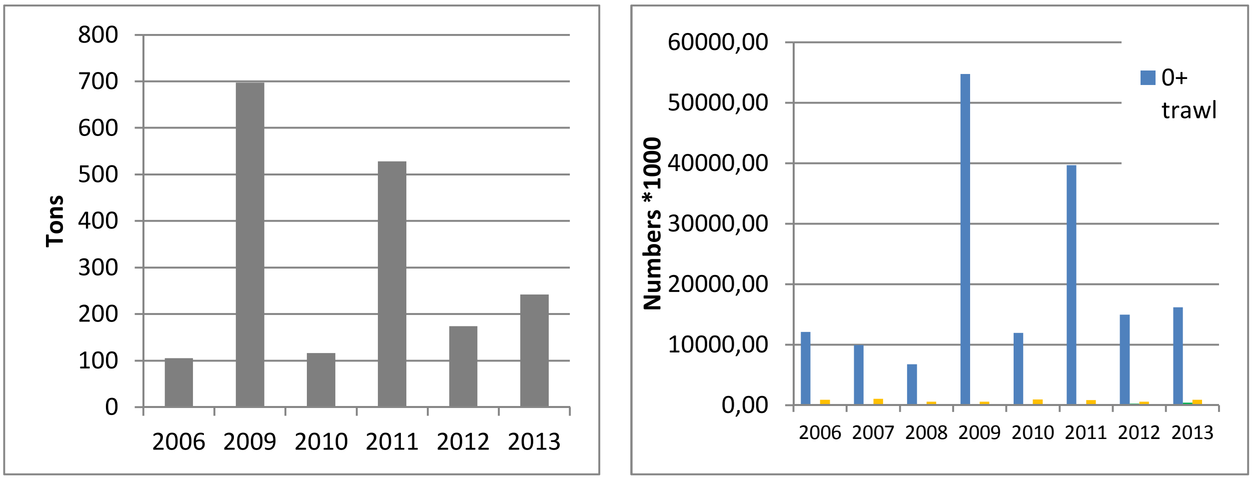


Fig. 4.2.7.4.5.1. Hake in GSA 9. Annual discards (left); age composition by year and fleet (right).

4.2.7.4.6 Fishing Effort

The fishing capacity of the GSA 9 has shown in these last 20 years a progressive decreases. Fishing effort (kw*fishing days) performed by the GSA 09 trawlers decreased of 28% since 2004, from about 15,000,000 to 11,000,000 in 2013. The effort displayed by the artisanal fleet exploiting hake remained constant for vessels using trammel nets (GTR) whereas the effort of gillnetters decreased abruptly (-62%) in the last three years (Fig. 4.2.7.4.6.1).

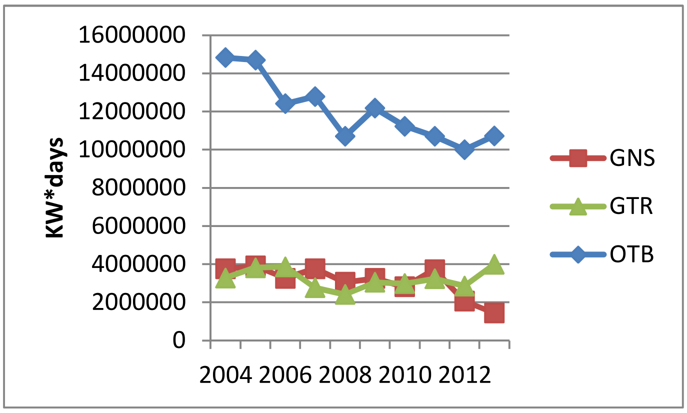
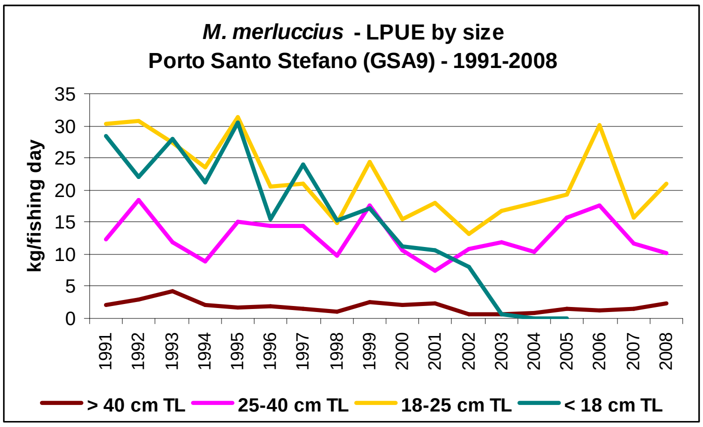


Fig. 4.2.7.4.6.1 Effort trends (days and kW*days) by major fleets, 2004-2007.

Trends in the landings per unit of effort (LPUE in kg by fishing day) of the trawl fishing fleet of S. Stefano fleets decreased continuously from 1991 (Fig. 4.2.7.4.6.2). As showed by the trend by size class the reduction in LPUE is due to the progressive disappearance of small hakes from landings as effect of the introduction of the EU Regulations (1626/94 and 1967/06) concerning minimum landing size (20 cm TL for hake)



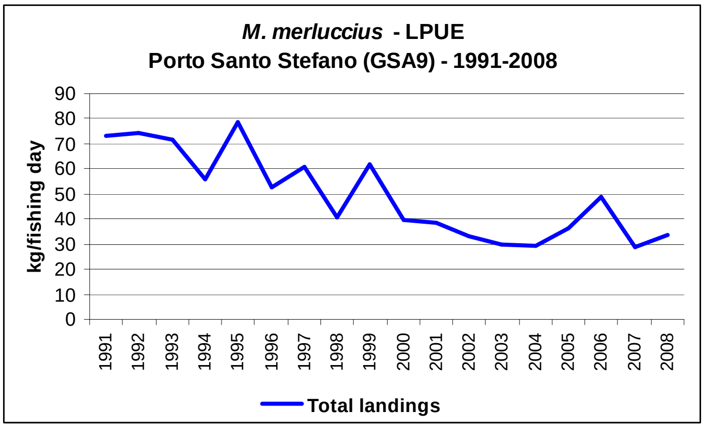


Fig. 4.2.7.4.6.2. Hake in GSA 9. Landings per unit of effort (LPUE) of the Porto Santo Stefano trawl fleet (1991-2008); above: LPUE by size class; below: total LPUE.

4.2.7.5 *Scientific surveys: MEDITS*

4.2.7.5.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 9 the following number of hauls were reported per depth stratum (Tab. 4.2.7.5.1.1).

Tab. 4.2.7.5.1.1. Number of hauls per year and depth stratum in GSA 9, 1994-2009.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13	13	14
GSA09_050-100	19	20	18	19	18	19	20	20	15	15	15	14	16	16	13	14
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26	28	27
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33	30	28
GSA09_500-800	31	30	31	28	30	28	27	29	24	22	21	20	20	17	18	20

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n
It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-

distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. 2004).
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

4.2.7.5.2 Geographical distribution

According to recent studies (Orsi Relini et al., 2002), the density of hake recruits concentrations in nursery areas in GSA 9 is by far higher than that of the other GSAs of the western Mediterranean and, probably, also of the other Mediterranean GSAs (Fig. 4.2.7.5.2.1).

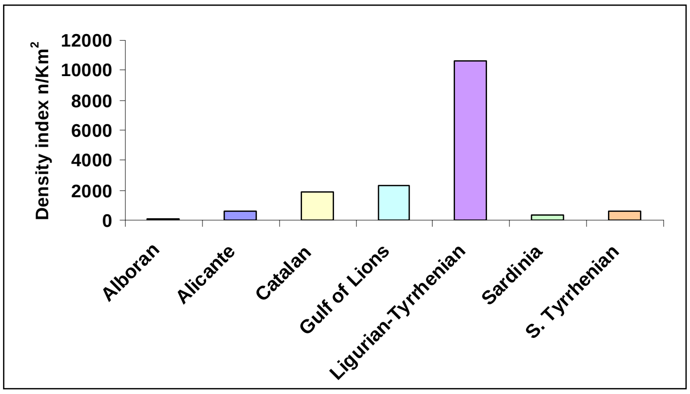


Fig. 4.2.7.5.2.1. Hake in GSA 9. MEDITS density indices of the hake recruits (<12 cm TL) obtained in different Mediterranean GSAs (from Orsi-Relini et al., 2002, modified).

Generalized additive models were developed to investigate hake recruitment dynamics in the Tyrrhenian Sea in relation to spawner abundance and selected key oceanographic variables. Thermal anomalies in summer, characterized by high peaks in water temperature, revealed a negative effect on the abundance of recruits in autumn, probably due to a reduction in hake egg and larval survival rate. Recruitment was reduced when elevated sea-surface temperatures were coupled with lower levels of water circulation. Enhanced spring primary production, related to late winter low temperatures could affect water mass productivity in the following months, thus influencing spring recruitment. In the central Tyrrhenian a dome-shaped relationship between wind mixing in early spring and recruitment could be interpreted as an "optimal environmental window" in which intermediate water mixing level played a positive role in phytoplankton displacement, larval feeding rate and appropriate larval drift (Bartolino *et al*., 2008b) (Fig. 4.2.7.5.2.2).

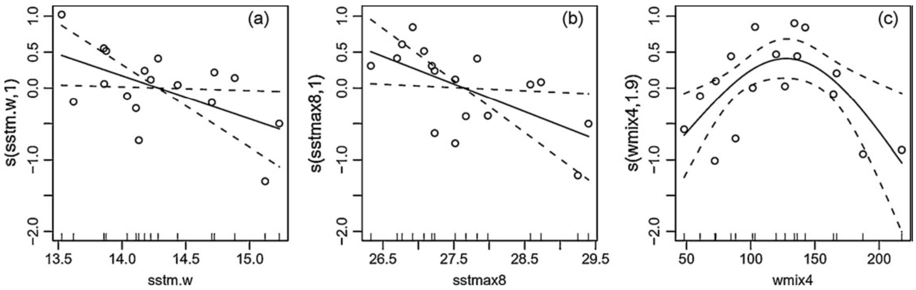


Fig. 4.2.7.5.2.2. Effects of: (a) sstm.w, (b) sstmax8 and (c) wmix4 on hake recruitment in the central Tyrrhenian (from Bartolino et al., 2008b).

The temporal trend in spatial distribution of hake > 26 cm TL showed a clear reduction of distribution area, particularly in the Tyrrhenian part of the GSA (GRUND data, Fig. 4.2.7.5.2.3).

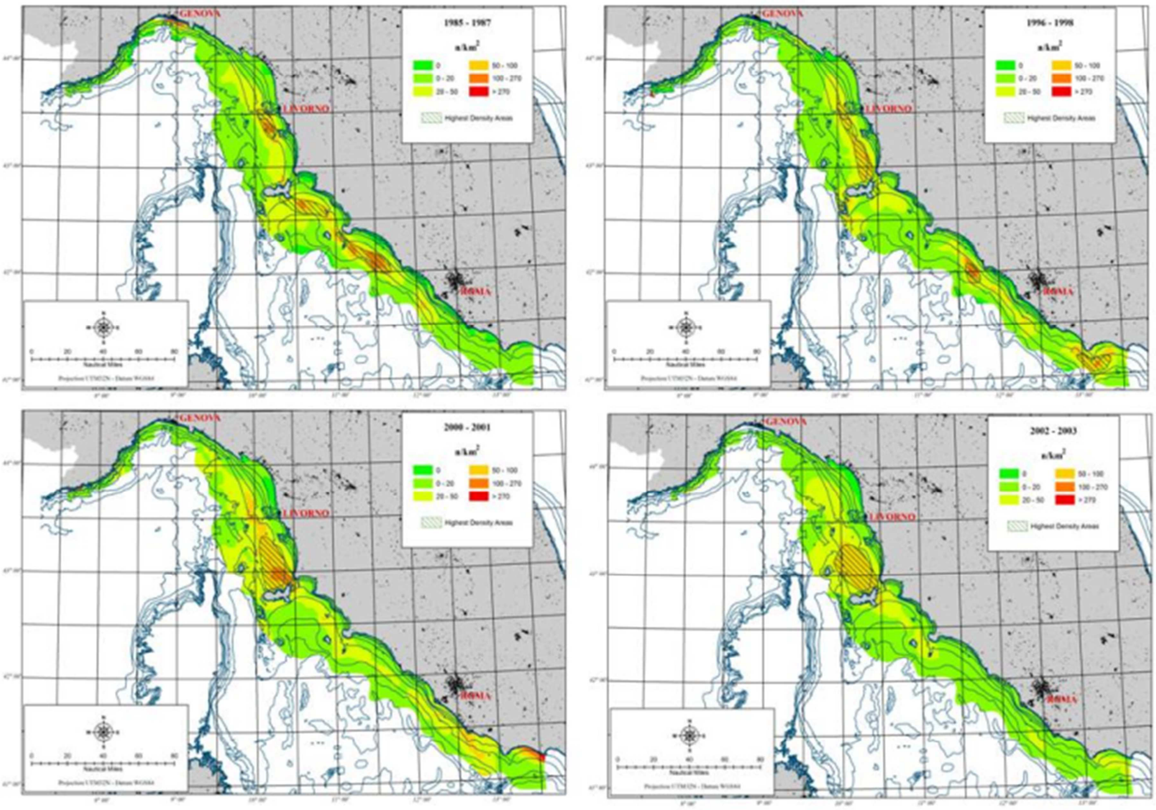


Fig. 4.2.7.5.2.3. Distribution of hake larger than 26 cm TL in 1985-87, 1996-98, 2000-01, 2002-03.

4.2.7.5.3 Trends in abundance and biomass

The national GRUND trawl survey (Relini, 1998) has been performed out along the Italian coasts in addition to MEDITS. It has been carried out since 1985, with some years lacking (1988, 1989 and 1999, 2007). Sampling is random stratified, except in the period 1990-93 where a different sampling design, based on transects, was applied. Locations of stations were selected randomly within each stratum in the period 1985-87, while starting from 1996, the same stations were sampled the following years. Therefore from 1994 in Italy two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys provide integrate pictures on different seasons, allowing to monitor the most important biological events (recruitment, spawning) for the majority of the demersal species.

Figure 4.2.7.5.2.4 shows the density and biomass indices of hake obtained from 1994 to 2009; no evident trends are present.

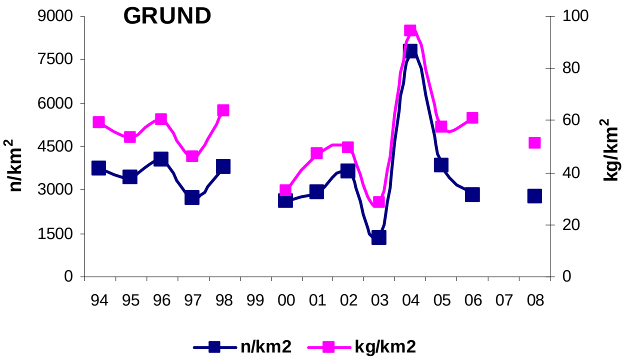


Fig. 4.2.7.5.2.4. Hake in GSA 9. GRUND survey: density and biomass indices.

Figure 4.2.7.5.2.5 displays the re-estimated trend in hake abundance and biomass in GSA 9 (kg/h) based on the MEDITS DCR data call. Both biomass and density showed large fluctuactions without temporal trends..

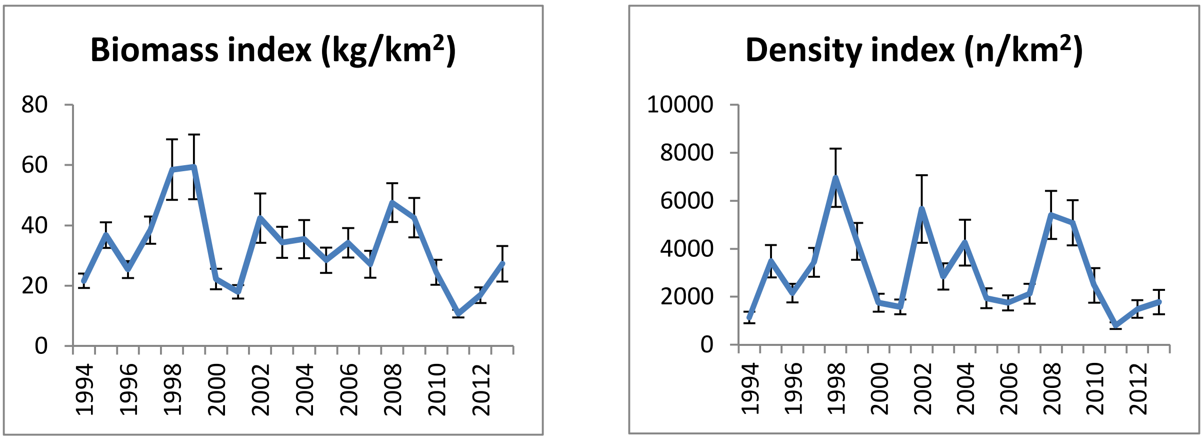


Fig. 4.2.7.5.2.5. Hake in GSA 9. MEDITS time series of survey biomass and density indices (mean +/- standard deviation).

4.2.7.5.4 Trends in abundance by length or age

The following Figs. 4.2.7.5.4.1 and 4.2.7.5.4.2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2009.

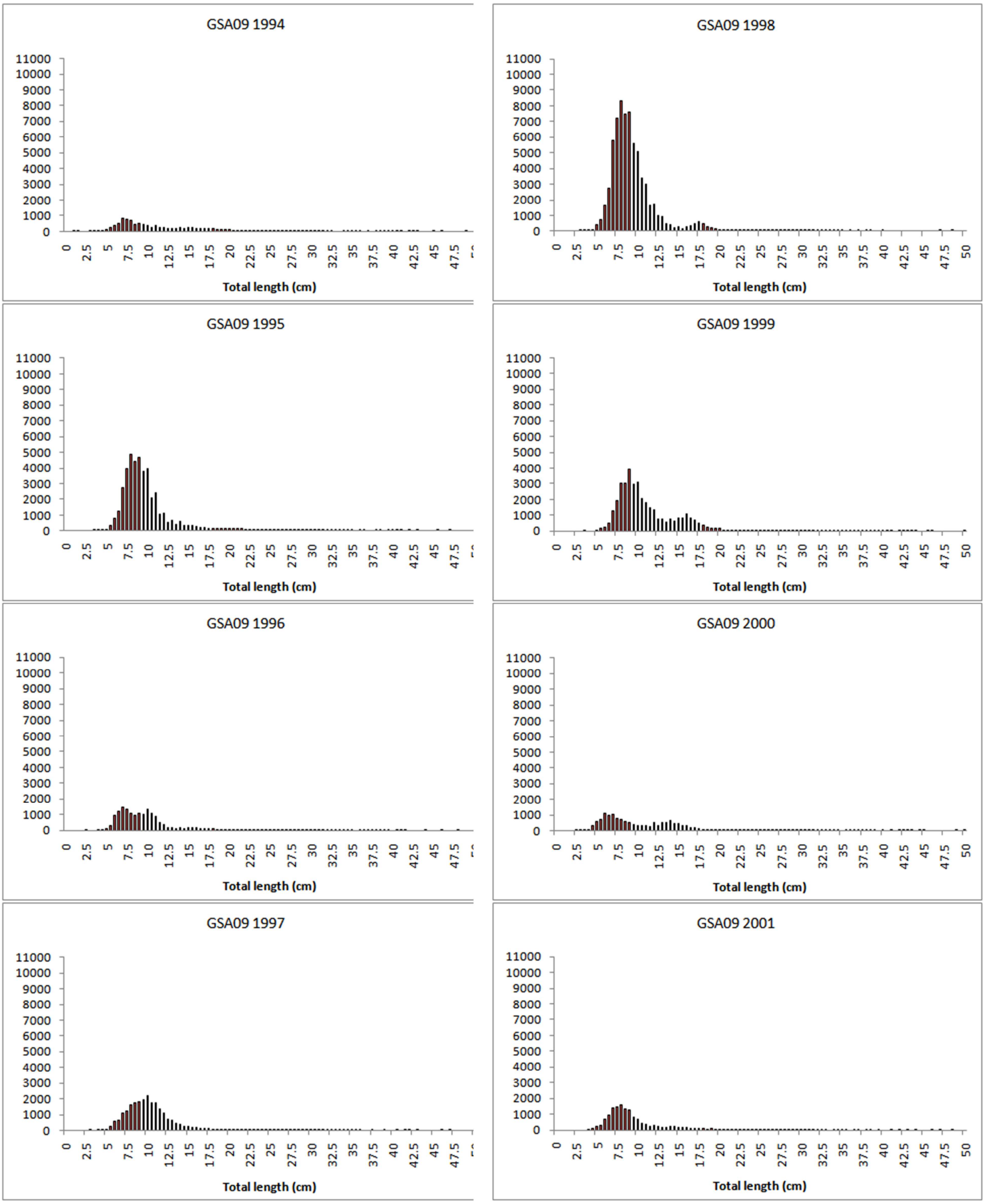


Fig. 4.2.7.5.4.1. Hake in GSA 9. Stratified abundance indices by size, 1994-2001.

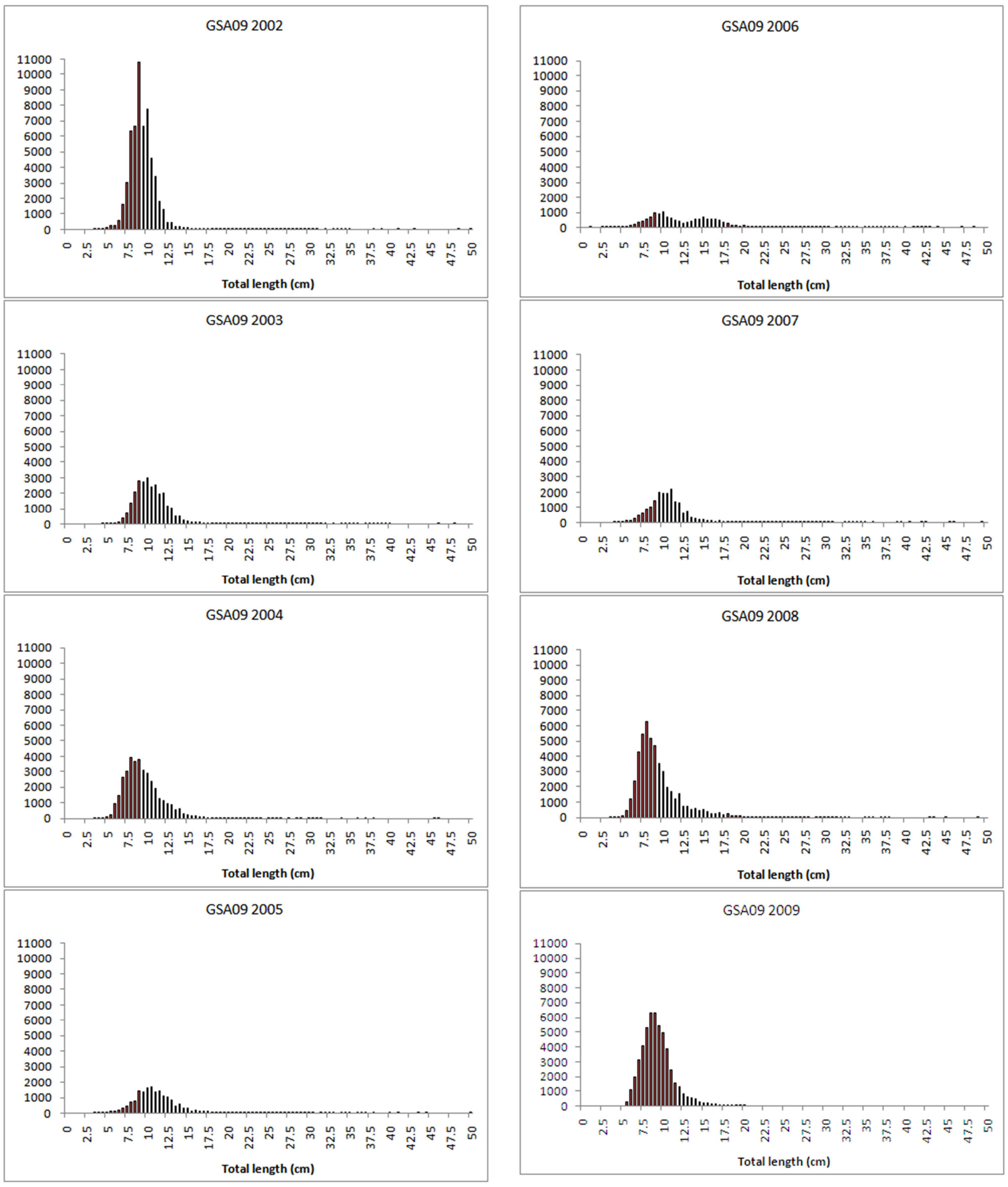


Fig. 4.2.7.5.4.2. Hake in GSA 9. Stratified abundance indices by size, 2002-2009.

4.2.7.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.7.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.7.6 Assessment of historic stock parameters

Due to its importance as demersal resource, hake has been object of several assessments in the GSA 9 (Reale *et al*., 1995; Fiorentino et al., 1996; Ardizzone et al., 1998; Abella *et al.*, 1999; 2007; Colloca *et al*., 2000). These results are published and regularly updated in the GFCM SAC sheets and in STECf reports.The assessments, often performed with different approaches in different periods or in different subareas of the GSA 9, showed substantially similar results. The hake in the GSA 9 seems to be in a “chronic” overexploitation with a growth overfishing situation and any apparent improvements related to the recent decline in fishing effort.

4.2.7.6.1 Method: XSA

4.2.7.6.2 Justification

An XSA was performed using DCF data from 2005 to 2013 calibrated with survey abundance indices (MEDITS).

4.2.7.6.3 Input parameters

The following Tab. 4.2.7.6.3.1 lists the input data of the XSA, i.e. catch at age, weight at age, matutity at age, natural mortality at age. The tuning series at age (MEDITS) are showed in Tab. 4.2.7.6.3.2.

Tab. 4.2.7.6.3.1. Hake in GSA 9. Input parameters of the XSA: natural mortality (M) at age, maturity at age, catch at age in numbers (thousands), weight at age and in the stock (kilograms).

M vectors at age

age	Year (2005-20139
0	1.30
1	0.60
2	0.46
3	0.41
4	0.30
5+	0.20

Maturity at age

age	Year (2005-20139
0	0
1	0.25
2	0.90
3	1
4	1
5+	1

Number at age in the catch (thousands)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	45189.5	19322.6	13176.1	25961.5	57213.0	9317.3	36656.8	9817.0	9791.6
1	8874.0	6266.6	8363.4	6908.5	7805.2	5477.8	6902.4	4800.2	8013.8
2	574.1	1117.1	591.2	411.3	460.9	574.5	581.6	357.5	389.1
3	47.2	164.4	125.9	91.5	91.1	136.1	124.7	88.5	43.8
4	12.5	56.8	35.4	25.8	40.5	65.7	47.8	34.5	17.3
5+	7.6	8.0	19.0	14.1	16.0	37.4	23.1	15.4	9.3

Weight-at-age in the catch and in the stock (kg)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.006	0.006	0.006	0.005	0.007	0.006	0.006	0.006	0.006
1	0.103	0.136	0.128	0.122	0.103	0.119	0.119	0.119	0.119
2	0.432	0.612	0.603	0.596	0.454	0.539	0.539	0.539	0.539
3	1.34	1.369	1.359	1.349	1.36	1.356	1.356	1.356	1.356
4	2.323	2.302	2.279	2.29	2.447	2.328	2.328	2.328	2.328
5+	3.202	3.312	3.284	3.288	3.202	3.257	3.257	3.257	3.257

Tab. 4.2.7.6.3.2. Hake in GSA 9. MEDITS survey data used as tuning for the XSA.

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	1751.96	1321.75	949.36	1806.89	1684.21	773.52	748.71	1459.42	1315.04
1	51.37	81.03	45.37	64.95	61.96	43.54	35.17	26.71	45.84
2	1.32	2.64	1.92	1.70	1.28	2.99	1.69	1.14	1.02
3	0.18	0.36	0.90	0.29	0.40	0.10	0.38	0.48	0.10
4	0.10	0.10	0.17	0.27	0.18	0.09	0.10	0.24	0.01
5+	0.25	0.08	0.07	0.25	0.07	0.08	0.01	0.07	0.01

4.2.7.6.4 Results

XSA was run setting shrinkage at 0.5, 1.0, 1.5, 2.0 to assess the effect of different settings on the outcomes of the method. The final settings of the other XSA's parameters were: Qrage=1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=2.

As showed in Figure 4.2.7.6.4.1, the four different settings produced similar trend for recruitment and SSB. Fbar was estimated to be a little be higher by the model with 1.5 and 2.0 shrinkage. It is however important to remark that XSA, forcing asymptotically flat selectivity, is prone to overestimate the fishing mortality of big hake due to their poor trawl catchability. In addition this implies also an SSB underestimation.

Residuals are low, below 1 for all the four model runs (Fig. 4.2.7.6.4.2). The model with shrinkage 1.0 was adopted as final model based on retrospective analysis which returned a little bit more consistent pattern (Fig. 4.2.7.6.4.3).

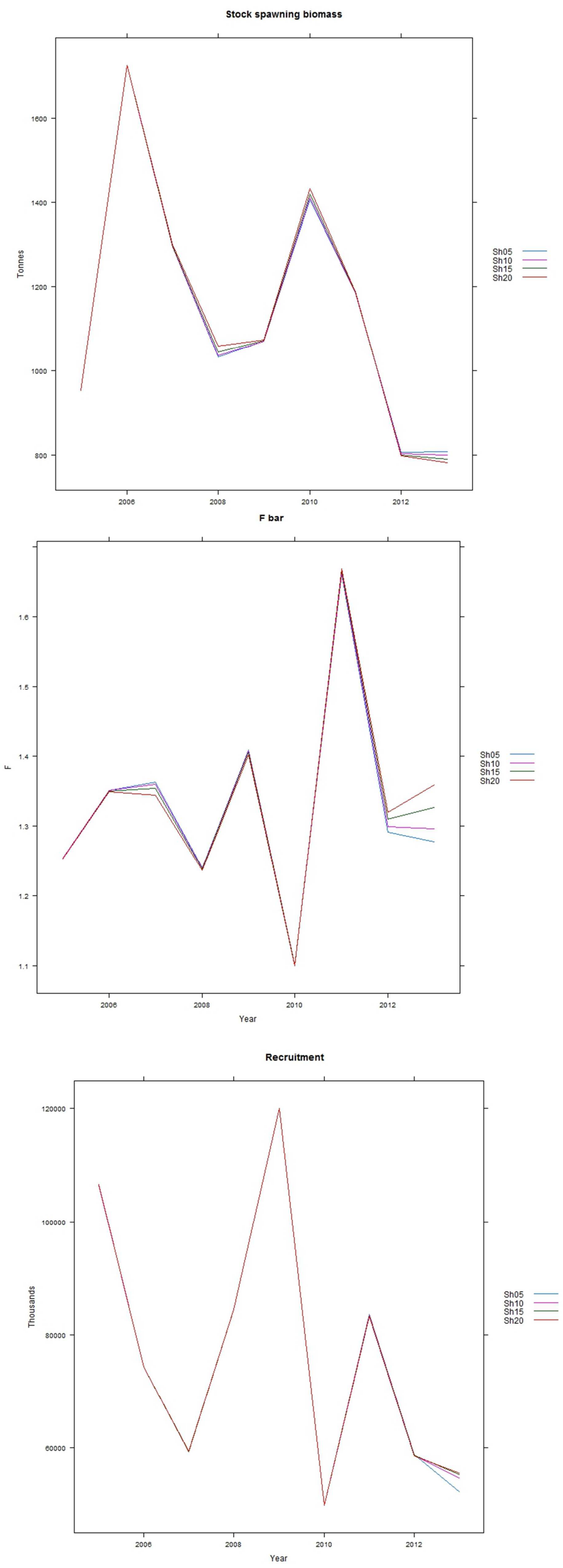


Fig. 4.2.7.6.4.1. Hake in GSA 9. Estimates of SSB, recruitment and F using different values of shrinkage.

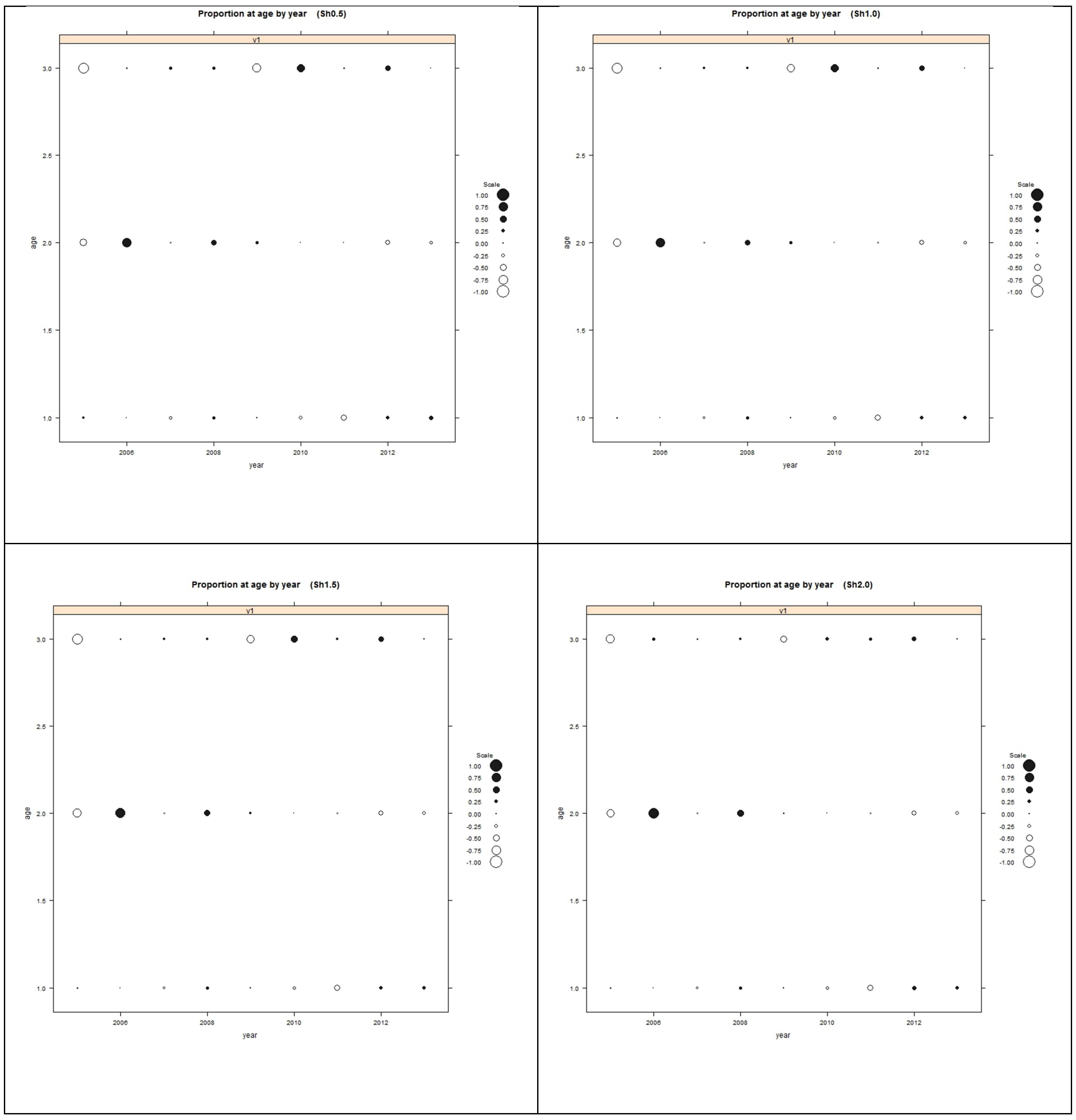


Fig. 4.2.7.6.4.2. Hake in GSA 9. Residuals at age obtained with XSA models with different level of shrinkage.

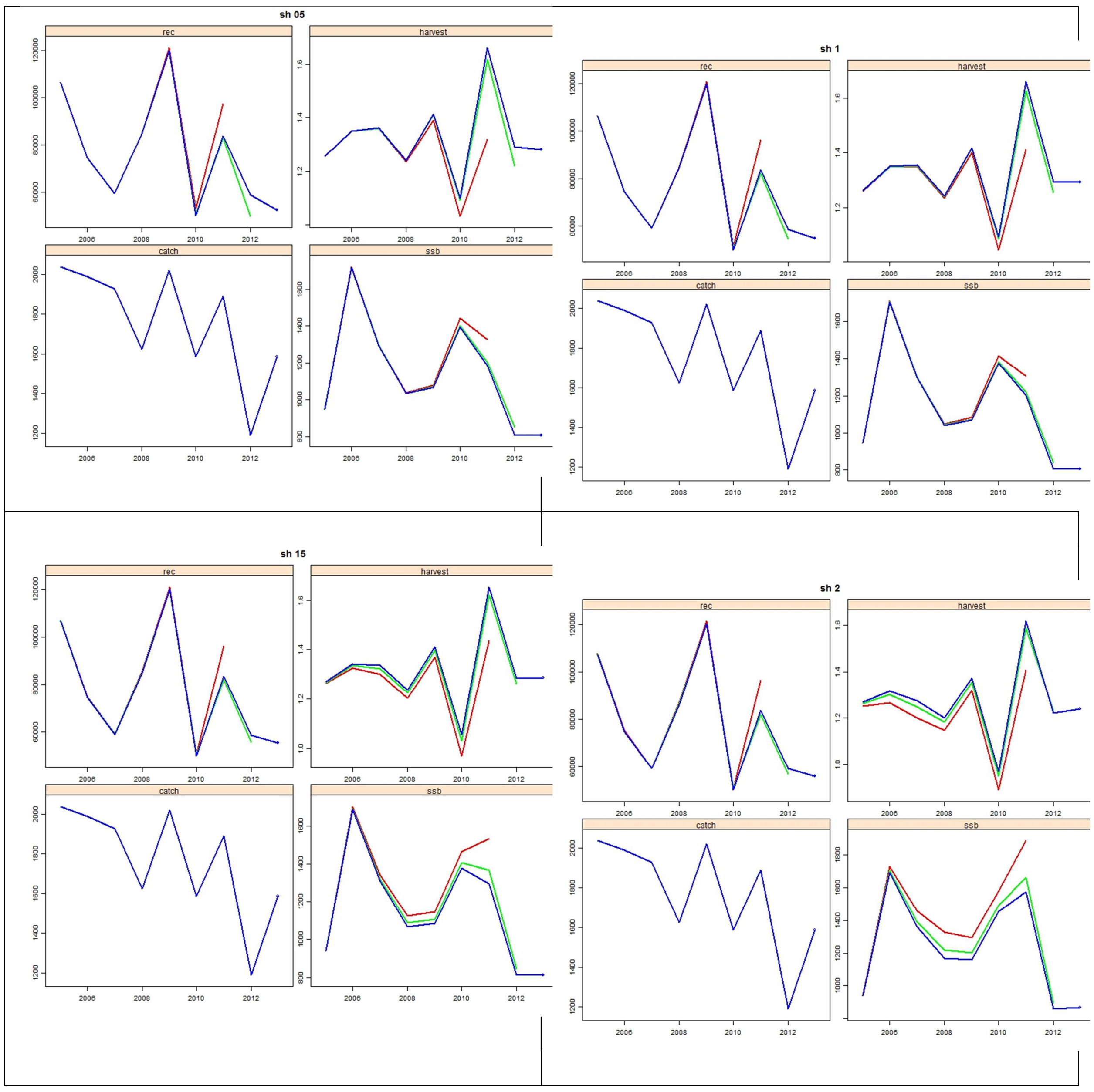


Fig. 4.2.7.6.4.3. Hake in GSA 9. Retrospective analysis for of models with shrinkage set at 0.5, 1.0, 1.5, 2.0

In 2005-2013, the SSB ranged between about 790 and 1724 t. In the same period recruitment at age 1 fluctuated widely between 50 and 120 million (Table 4.2.7.6.4.1). XSA estimates of Fbar0-2 showed annual fluctuactions, largely dependent by variations in F at age 0, between 1.1 and 1.3 ($F_{0\text{-}2}$=1.30 in 2013).

Table 4.2.7.6.4.1. Hake in GSA 9. XSA results (F at age, F, numbers at age, SSB, recruitment).

F at age

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	1.13	0.58	0.47	0.71	1.37	0.39	1.19	0.34	0.37
1	1.57	1.72	2.17	1.83	1.87	1.65	2.28	1.88	1.95
2	1.06	1.76	1.43	1.17	0.99	1.27	1.51	1.68	1.58
3	1.32	1.74	1.82	1.46	1.43	1.44	1.89	1.78	1.76
4+	1.32	1.74	1.82	1.46	1.43	1.44	1.89	1.78	1.76
$Fbar_{0-2}$	1.25	1.35	1.36	1.24	1.41	1.10	1.66	1.30	1.30

Numbers at age

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	106516.5	74317.6	59310.9	84438.2	120039.5	49871.2	83535.1	58673.6	54740.3
1	13849.2	9370.9	11385.5	10054.7	11259.8	8351.8	9232.5	6910.1	11375.9
2	1052.9	1582.4	919.8	711.9	883.5	951.5	881.0	516.4	578.3
3	75.3	230.0	172.6	138.6	139.2	207.8	168.8	122.5	60.9
4+	32.0	90.6	74.7	60.4	86.3	157.4	96.0	69.1	37.0

SSB and recruitment

	2005	2006	2007	2008	2009	2010	2011	2012	2013
SSB (tons)	951.7	1724.7	1295.6	1043.2	1071.2	1419.3	1184.4	800.0	790.3
Recruitment (million)	106.6	74.3	59.3	84.4	120.0	49.9	83.4	58.6	55.3

4.2.7.7 Long term prediction

4.2.7.7.1 Justification

Equilibrium YPR reference points for the stock assessed through the Yield software (Hoggarth *et al*., 2006) were estimated.

4.2.7.7.2 Input parameters

Equilibrium YPR reference points for the stock were estimated assuming recruitment fluctuating randomly around a constant value and 20% uncertainty in input parameters.

4.2.7.7.3 Results

Yield software quantified uncertainty by repeatedly selecting a set of biological and fishery parameters by sampling from the probability distributions for uncertain parameters set by the user, and then calculating the quantities of interest. In this sampling, it is assumed that each of the uncertain parameters are independently distributed, even though for some biological parameters, this assumption is almost certainly incorrect (Hoggarth *et al*., 2006). F_{max} and F_{ref} , this latter corresponding to F at SSB/initial SSB = 0.30, were assumed as limiting reference points. $F_{0.1}$ was assumed as target reference point. The probability distributions of the three RPs showed a considerable variations (Fig. 4.2.7.7.3.1). The following mean values were obtained: F_{max} = 0.35; $F_{0.1}$= 0.22 and F_{ref} = 0.28. The maximum predicted values were respectively 0.59 (F_{max}), 0.36 (F_{01}) and 0.41 (F_{ref}).

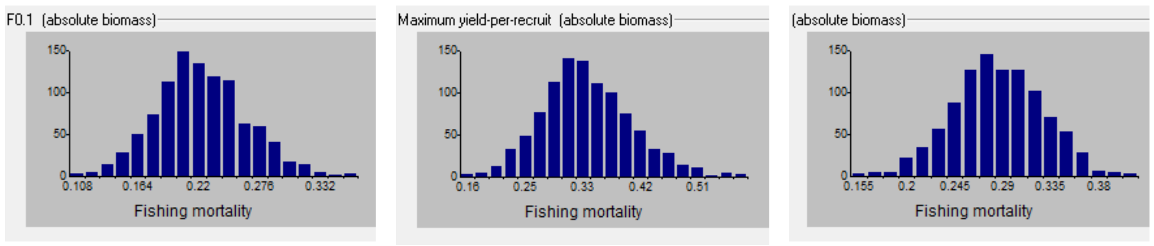


Fig. 4.2.7.7.3.1. Hake in GSA 9. Probability distribution of reference points obtained using the Yield software (age groups 1-5).

4.2.7.8 Data quality

Data on landings and discards at length/age were available only since 2006.

4.2.7.9 Scientific advice

During the period analysed, SSB and recruitment have decline and F has been much larger than $F_{MSY.}$

4.2.7.10 Most recent state of the stock

State of the adult abundance and biomass

In 2005-2013, the SSB was estimate to be between 790 and 1419 t with levels estimated in 2012-2013 lower to levels calculated for 2005-2011. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juvenile (recruits)

Recruitment ranged between 50 and 120 million in the period 2005-2013 with a decreasing trend over the analysed time series.

State of exploitation

The current F (1.30) is larger than F_{MSY} (0.22), which indicates that hake in GSA 9 is exploited unsustainably.

4.2.7.11 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed FMSY level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.8 STOCK ASSESSMENT OF RED MULLET IN GSA 9

4.2.8.1 Stock Identification

Red mullet (*Mullus barbatus*) is distributed in GSA 9 along the shelf at depths up to 200m, but mainly concentrated in the depth range 0-100m. There is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on morphometrics. Under a management point of view, considering the lack of any evidence it is assumed here that inside the GSA 9 boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population. The GSA 9 boundaries are (as for other GSAs) arbitrary and certainly do not take under consideration neither the existence of local biological features nor of differences in the spatial allocation in fishing pressure within it. The hypothesis of a single stock of red mullet in GSA 9, which includes waters belonging to 2 different seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that does not show any spatial overlapping is almost unlikely. The inability to account for spatial structure reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

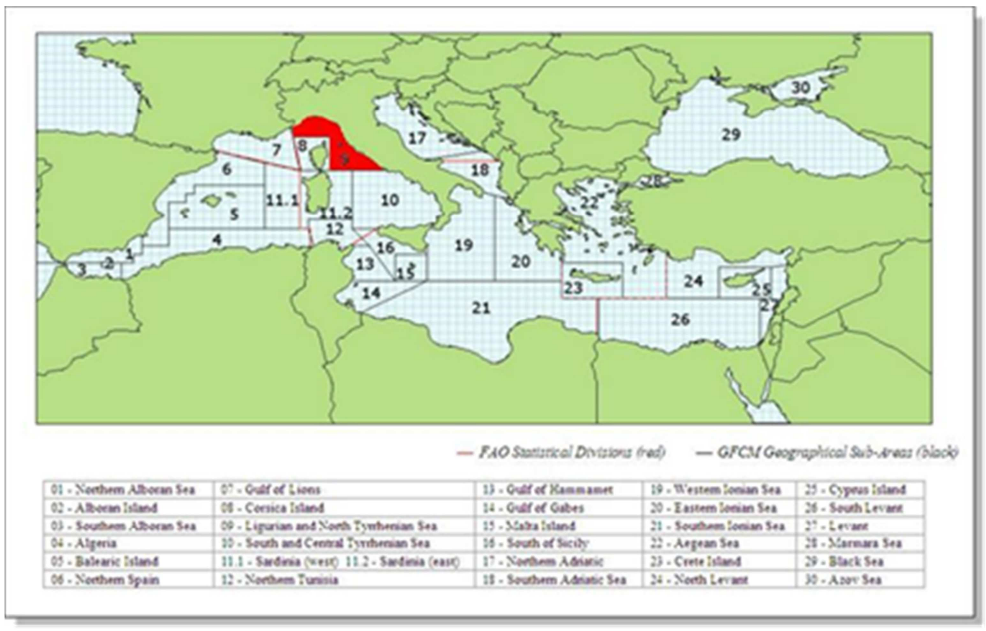


Fig. 4.2.8.1.1. Geographical location of GSA 9.

4.2.8.2 Growth

The species is fast growing, and reaches half of its total size at one year old. Some light differences in growth has been observed within different zones within the GSA 9. In zones where the species is less exploited with individuals more densely concentrated or where available food is reduced, the mean size of 6 months old individuals is from 1 to 1.5 cm lower than in other areas of the same GSA were the species is more highly exploited and hence less abundant. In any case, the parameters reported as follows may be considered suitable for the description of an average growth performance valid for the whole GSA 9.

The growth parameters representative for *M. barbatus* in the GSA9 utilized are the following:

L_{inf}=29, K=0.6, to=-0.1 (F); L_{inf}=20, K=0.59, to=-0.1(M); L/W : a=0.00053 b=3.12

Table 4.2.8.2.1. Red mullet in GSA 9. Weight at age .

Wt at age		Age				
		0	1	2	3	4
Year	2006	0.0037	0.0381	0.0814	0.1147	0.1363
	2007	0.0037	0.0381	0.0814	0.1147	0.1363
	2008	0.0037	0.0381	0.0814	0.1147	0.1363
	2009	0.0037	0.0381	0.0814	0.1147	0.1363
	2010	0.0037	0.0381	0.0814	0.1147	0.1363
	2011	0.0037	0.0381	0.0814	0.1147	0.1363
	2012	0.0037	0.0381	0.0814	0.1147	0.1363
	2013	0.0037	0.0381	0.0814	0.1147	0.1363

Table 4.2.8.2.2. Red mullet in GSA 9. Natural mortality at age .

M		Age				
		0	1	2	3	4
Year	2006	1.3	0.79	0.62	0.54	0.5
	2007	1.3	0.79	0.62	0.54	0.5
	2008	1.3	0.79	0.62	0.54	0.5
	2009	1.3	0.79	0.62	0.54	0.5
	2010	1.3	0.79	0.62	0.54	0.5
	2011	1.3	0.79	0.62	0.54	0.5
	2012	1.3	0.79	0.62	0.54	0.5
	2013	1.3	0.79	0.62	0.54	0.5

4.2.8.3 Maturity

The species reaches massively the sexual maturity at one year old. The proportion of mature individuals by age used in the analyses is as follows:

Table 4.2.8.3.1. Red mullet in GSA 9. Maturity at age.

Maturity at age		Age				
		0	1	2	3	4
Year	2006	0.0000	1.0000	1.0000	1.0000	1.0000
	2007	0.0000	1.0000	1.0000	1.0000	1.0000
	2008	0.0000	1.0000	1.0000	1.0000	1.0000
	2009	0.0000	1.0000	1.0000	1.0000	1.0000
	2010	0.0000	1.0000	1.0000	1.0000	1.0000
	2011	0.0000	1.0000	1.0000	1.0000	1.0000
	2012	0.0000	1.0000	1.0000	1.0000	1.0000
	2013	0.0000	1.0000	1.0000	1.0000	1.0000

In GSA 9 there have been performed studies on fecundity. The following relationship of fecundity at size (in cm) was defined in the area: Fec= 0.7599*TL^3.336

4.2.8.4 Fisheries

4.2.8.4.1 General description of Fisheries

Red mullet is among the most commercially important species in the area and among the prevalent components of a species assemblage that is the target of the bottom trawling fleets operating near the coast. It dominates the catch specially in late summer-autumn when the juveniles of the species are densely concentrated near the coast and very vulnerable to trawlers. The species in GSA 9 is mainly caught with different variants of the Italian bottom trawl net (tartana, volantina and francese). Differences among gears mainly regard vertical opening. The small mesh size of the cod end in all cases potentially defines a very precocious size/age of first capture. For the current mesh size age at 50% of selectivity was estimated as about 7-8cm. Set nets used by artisanal fleets catch modest quantitative of larger individuals, in general over 12 cm TL.

Thefishing pressure exerted on this species on different zones of GSA 9 is quite variable. Such variations depend on spatial differences on structural composition of the operating fleets, characteristics of the grounds and on the choices of target among fleets and zones. Red mullet catch rates are higher during the post-recruitment period (from September to November). About 200 of the 350 trawlers and a small number of artisanal vessels exploit the species in the GSA9. Annual landings, mostly proceeding from trawling, ranged from 1050 to 693 tons from 2006 and 2013. Discards of undersized individuals is in general limited (10% in weight was estimated in 2006), mainly occurring in autumn when new recruits are concentrated near the shore. Illegal landings of juveniles may occur but can be considered of limited importance and less important in recent years.

4.2.8.4.2 Management regulations applicable in 2014

Fishing closure for trawling: a 45 days trawling ban has been enforced in GSA 9 in late summer. The measure was compulsory in the more recent years. Minimum landing sizes: EC regulation 1967/2006 defined 12 cm TL as minimum legal landed size for red mullet. Cod end mesh size of trawl nets: 50 mm (stretched, diamond meshes) or alternatively a 40 mm codend with square mesh geometry. It was not observed a noticeable increase in the size of entering to the fishery with the new introduced changes because the exploitation pattern is only partially conditioned by the gear selectivity. Trawling is not allowed neither within three nautical miles from the coast nor at depths less than 50 m when this depth is reached at a distance shorter than 3 miles from the coast.

4.2.8.4.3 Catches

Landings reported through the Data collection regulation are listed in the following tables. Since 2006 annual landings varied between 1050 to 693 tons. Demersal bottom trawlers landings dominate by far. Landings size shows a very high seasonal variability, with peaks at the end of summer (September) determined by an increase in availability after the massive recruitment on the coastal area.

Table 4.2.8.4.3.1. Red mullet in GSA 9. Catch at age and discard by the two main fisheries.

4.2.8.4.4 Landings

2006
2007
2008
2009 728 80.1 808.1
2010
2011
2012
2013

total OTB								
	2006	2007	2008	2009	2010	2011	2012	2013
0	18817.54	4257.811	8692.462	6479.456	4152.615	4882.364	5216.631	11808.65
1	19453.39	17549.46	16556	12292.69	12308.61	12677.1	11803	11286.5
2	4718.064	5353.958	3168.549	3579.6	3536.144	3608.441	3210.857	2745.754
3	769.814	1030.68	338.732	686.135	619.932	516.385	513.066	429.495
4	160.607	264.903	57.388	136.061	149.896	142.134	93.316	91.762

TOTAL SMALL SCALE								
	2006	2007	2008	2009	2010	2011	2012	2013
0	1.13	0.241	8.321	3.328	0.649	6.204	12.527	86.895
1	178.276	105.873	152.831	231.468	331.462	934.32	569.755	970.327
2	64.353	48.491	30.165	110.87	122.246	280.362	295.768	285.333
3	20.462	12.941	18.886	32.537	67.79	112.889	80.536	132.416
4	8.284	1.814	6.562	4.749	3.512	44.94	13.71	47.133

age	DISCARD						
0	7980.466	11737.69	5200.401	6711.824	1933.846	3354.613	2314.172
1	0	0	10.30018	13.29378	17.75671	51.48042	0.906276

Table 4.2.8.4.4.1. Red mullet in GSA 9. Official data on catches, landings and discard (tons).

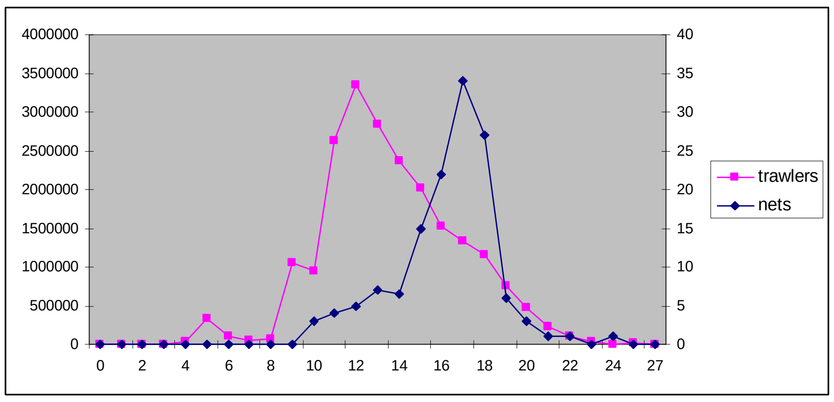


Fig. 4.2.8.4.4.1. Red mullet in GSA 9. Size distribution of the catch in the main fisheries (trawlers and set nets).

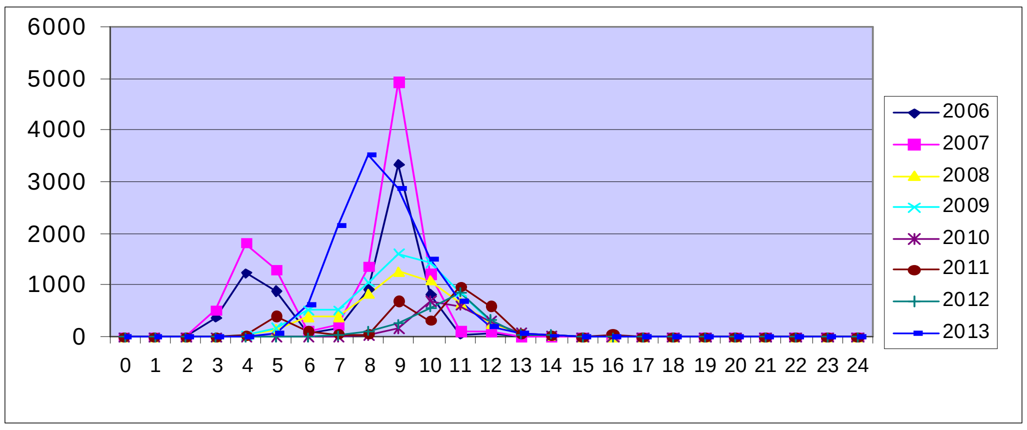


Fig. 4.2.8.4.4.2. Red mullet in GSA 9. Size distribution of the discards by year.

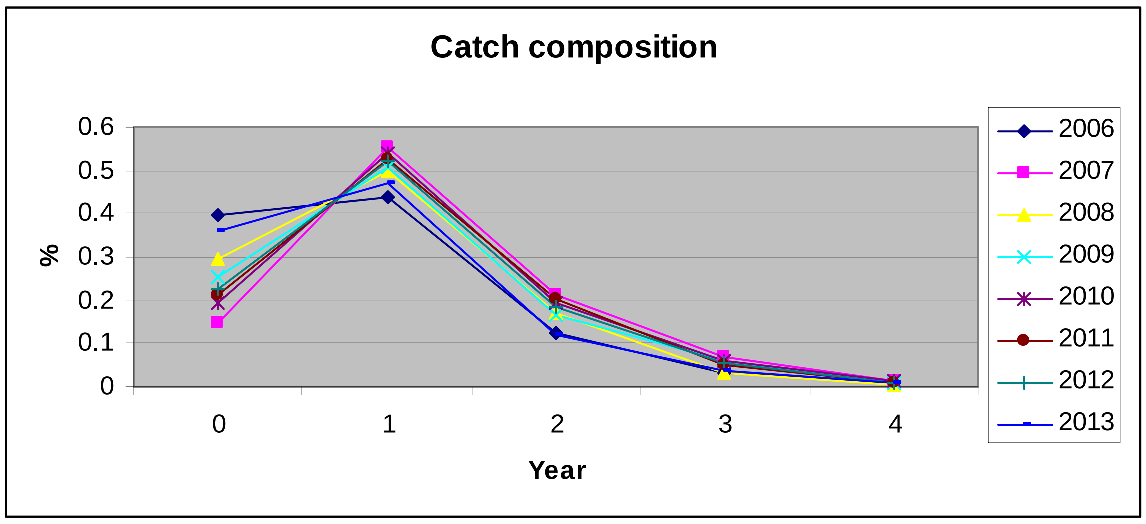


Fig. 4.2.8.4.4.3. Red mullet in GSA 9. Catch composition in the different analysed years.

4.2.8.4.5 Fishing Effort

The effort by fishing technique deployed in GSA 9 according to official data suggest a minor decrease for the main gear demersal trawls (OTB). It is however difficult to extract from these figures the real number of vessels that target red mullet over the whole GSA 9.

In the last 25 years a general decrease in the size of the fishing fleets operating in the GSA 9 targeting demersal species was observed in several ports of GSA 9. The number of vessels targeting the species in question and the changes (reduction) in number along the time is only known for some ports of the GSA. The reduction of number of vessels has been particularly important in Porto Santo Stefano fleet (about 50% of reduction in 16 years) in the South and in Viareggio (about 30% in 25 years) in the North. It is likely that this general reduction in numbers of vessels also apply for the fraction of the fleet that exert its fishing effort on M. barbatus over all the GSA 9 fleets.

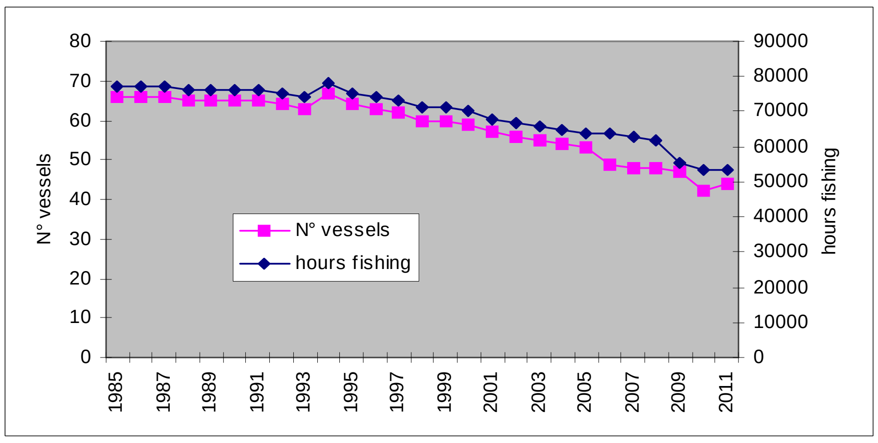


Fig 4.2.8.4.5.1. Number of vessels and fishing activity in the port of Viareggio (1990-2011).

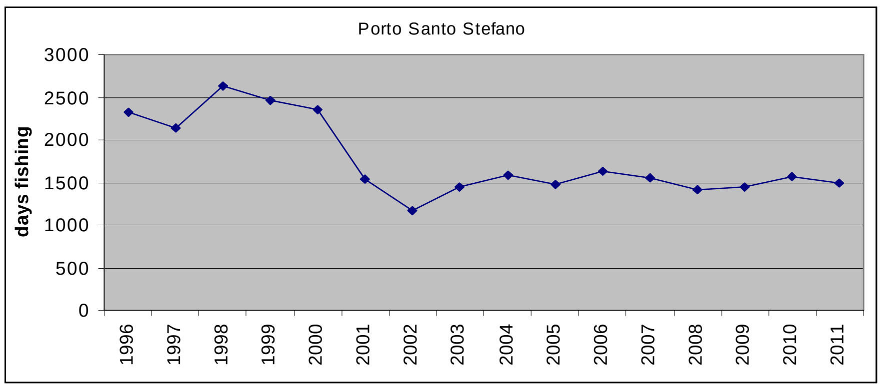


Fig 4.2.8.4.5.2. Days fishing in the port of Porto Santo Stefano (1996-2011).

4.2.8.5 Scientific surveys

4.2.8.5.1 Methods

Hauls were allocated with a random methods stratified by depth. Data were gathered by bathymetric strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes trawling duration. Only hauls considered valid were used in the computations. Valid hauls include the cases of null catches of the species.

Table 4.2.8.5.1.1. Number of tows by survey and depth stratum.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GSA09 010-050	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16
GSA09 050-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17
GSA09 100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30
GSA09 200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35
GSA09 500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120	120	120

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA

Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (sub-samples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

Table 4.2.8.5.1.2. Red mullet in GSA 9. Survey indices used in the analysis.

Survey index		Age				
		0	1	2	3	4
Year	2006	16.17	1.82	0.61	0.16	0.11
	2007	15.96	6.42	0.78	0.09	0.04
	2008	7.07	7.63	1.96	0.16	0.06
	2009	4.31	9.95	2.37	0.35	0.08
	2010	1.61	12.33	5.85	0.68	0.09
	2011	1.38	10.06	3.77	0.54	0.1
	2012	1.14	20.6	3.23	0.31	0.1
	2013	2.1	10.89	3.78	0.35	0.1

4.2.8.5.2 Geographical distribution

The species is distributed all along the continental shelf of the GSA 9, with major abundance in the depth range 0-100m. It is highly concentrated along the coastal stripe 0-30m when in late summer-early autumn juveniles massively settle to the bottom. The major nursery areas are allocated in the northern portion of the GSA 9, Northwards the Elba Island (yellow areas in Figure 4.2.8.5.2.1 and 2).

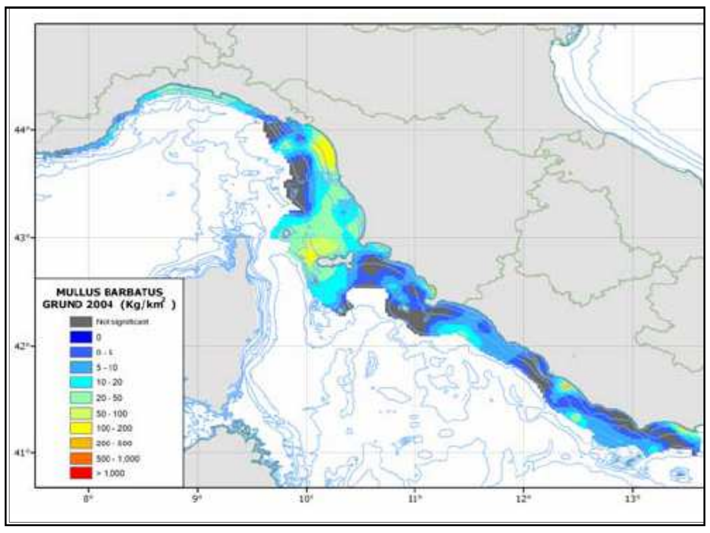


Fig. 4.2.8.5.2.1. Distribution of juveniles of red mullet in autumn in kg/km^2.

Also adults resulted were abundant in the Northern portion of the GSA 9.

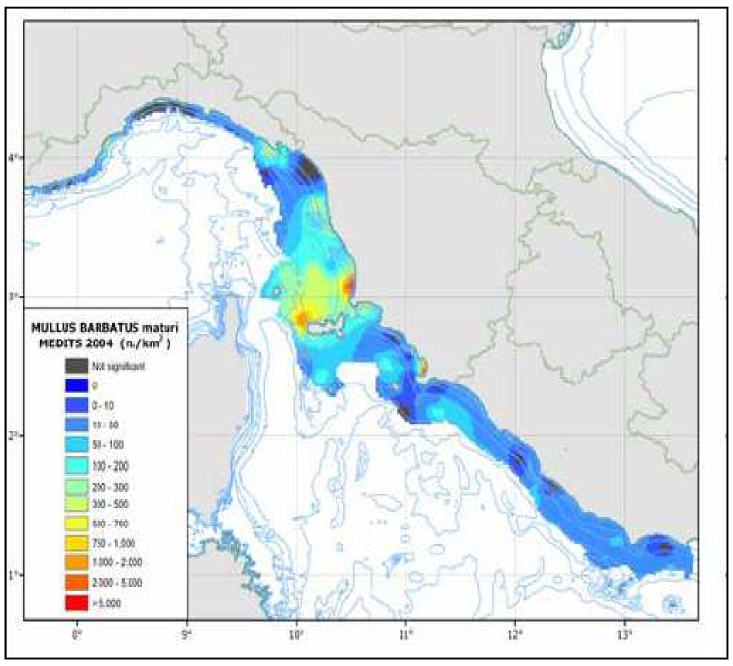


Fig. 4.2.8.5.2.2. Distribution of adults of red mullet in autumn in kg/km^2

The nursery concentrations show a marked spatial stability. Fig.4.2.8.5.2.3 shows the areas where a major stability along time has been observed (in dark brown)

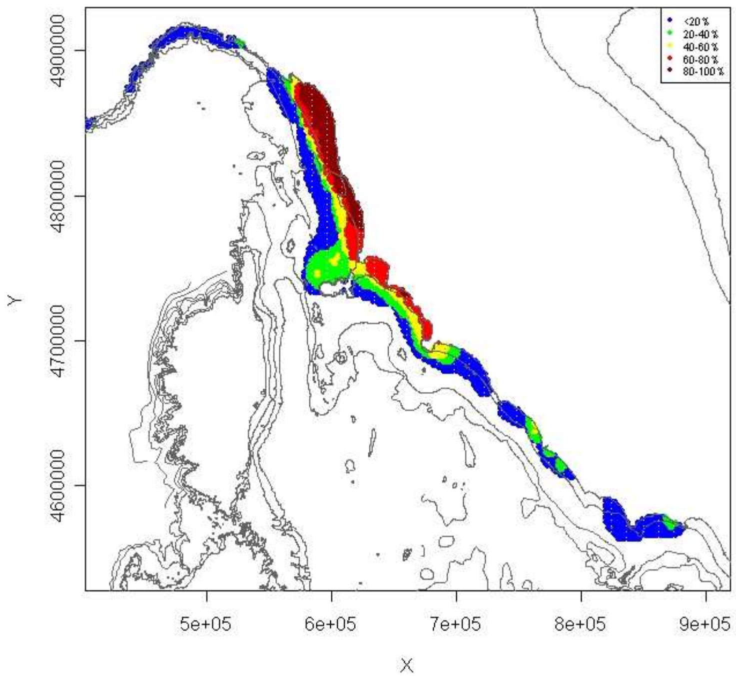


Fig. 4.2.8.5.2.3. Stability of the nursery areas of red mullet.

4.2.8.5.3 Trends in abundance and biomass

Abundance and biomass from MEDITS surveys show some stability, specially in the more recent years. In some years some peaks are observed, mainly due to the presence in the samples of juveniles, due to a delay in the time the surveys were done, that occurred after the massive comparison of the recently settled recruits.

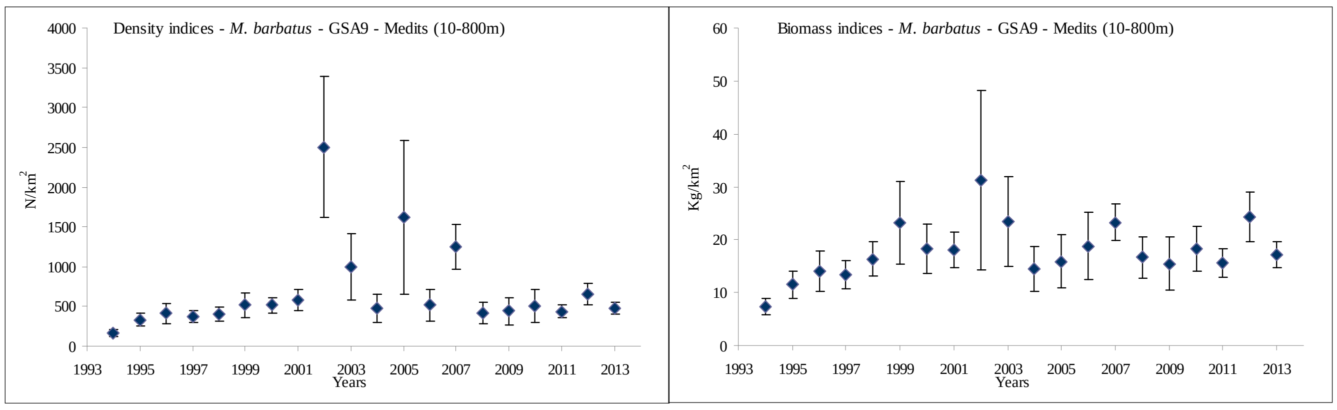


Fig. 4.2.8.5.3.1. Red mullet in GSA 9. Abundance (n/km^2) and Density (kg/km^2) by year from trawl surveys.

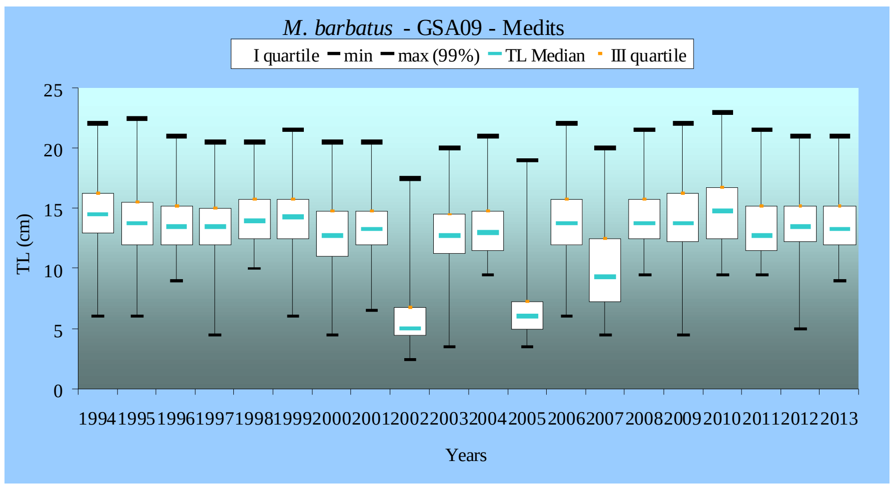


Fig. 4.2.8.5.3.2. Red mullet in GSA 9. Mean size of the individuals sampled in the trawls surveys.

4.2.8.5.4 Trends in abundance by length or age

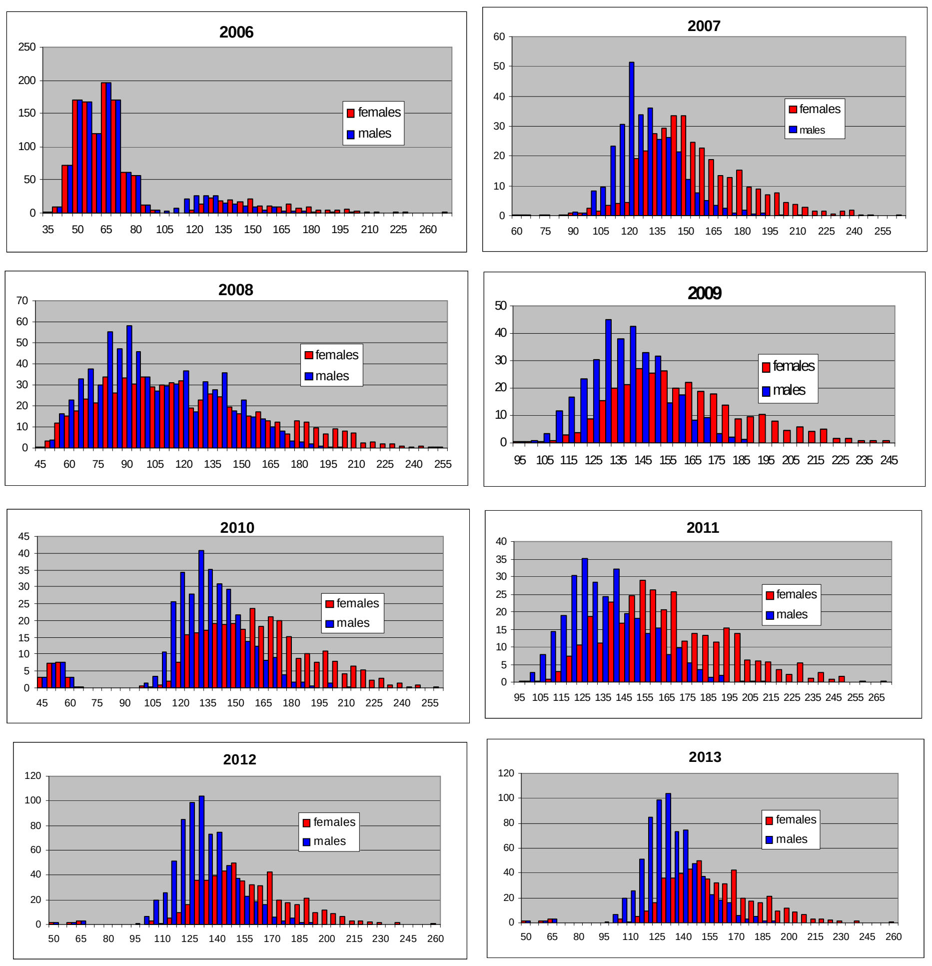


Fig. 4.2.8.5.4.1. Red mullet in GSA 9. Size composition of catch during the MEDITS surveys by sex.

4.2.8.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.8.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.8.6 Assessment of historic stock parameters

4.2.8.6.1 Methods: XSA

4.2.8.6.2 Justification

Virtual Population Analysis is a deterministic algorithm to sequentially calculate a matrix of stock numbers at age and a matrix of fishing mortality rates at age given a matrix of catch at age and a matrix of natural mortality at age. The algorithm back-calculates previous stock sizes using catch at age data, current-year stock size estimates, and assumptions about fishing mortality relationships between age groups. The XSA (Shepherd 1992, Darby and Flatman 1994) implemented in R was performed aimed at the estimation of a vector of F at size, using data on total annual catches by size, including discard. The procedure does not define an object function, but is based on an iteration procedure of the functional type.

In a previous meeting (2011) the ADAPT assessment approach was used. It combines deterministic virtual population analysis with a nonlinear least squares (NLS) objective function to estimate model parameters such as stock size at age through time.The quality of the available time series however did not allow satisfactory results. This was related to inconsistencies observed in the data set, regarding weights of the reconstructed numbers by age and official total landings and catches, and unreliable catch-at-age structures in some years. As an alternative, in 2011 an assessment was performed using the ASPIC.5 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). The model was used to estimate MSY, the ratios of both current biomass or F to the biomass or F at which MSY can be attained, and q (the catchability coefficient).

Several trials of the models were performed selecting shrinkage of different size in order to reduce unwanted assessment fluctuations driven by noise rather than signal. Shr=2 supplied the best results with minimum residuals without trends Values from 1 to 4 were tested.

All the analyses were performed by sex combined. In any case, size frequencies were splited by age using different sets of growth parameters for each sex in order to reduce errors and an overestimation of fishing mortality. Given that the landings were composed mainly of individuals between 0 and 1 years, these ages were selected as the F_{bar}.

4.2.8.6.3 Results

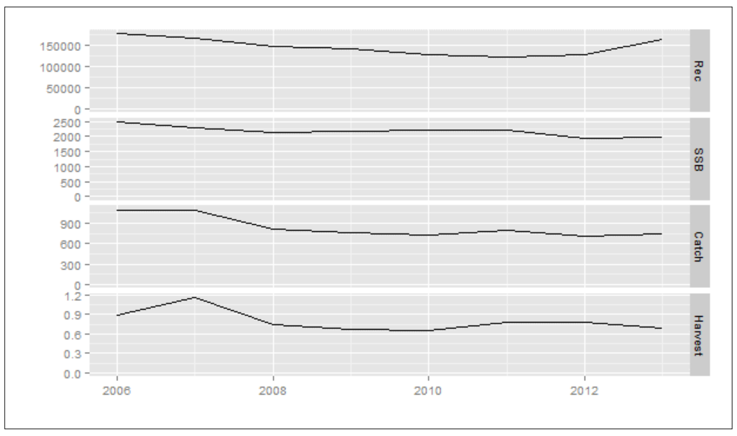


Fig. 4.2.8.6.3.1. Red mullet in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Sensitivity analyses were performed before running the final XSA. The sensitivity analyses performed were related to the use of different shrinkage weights and different shrinkage ages. The best residuals patterns were obtained with age 2 and hence this option was selected.

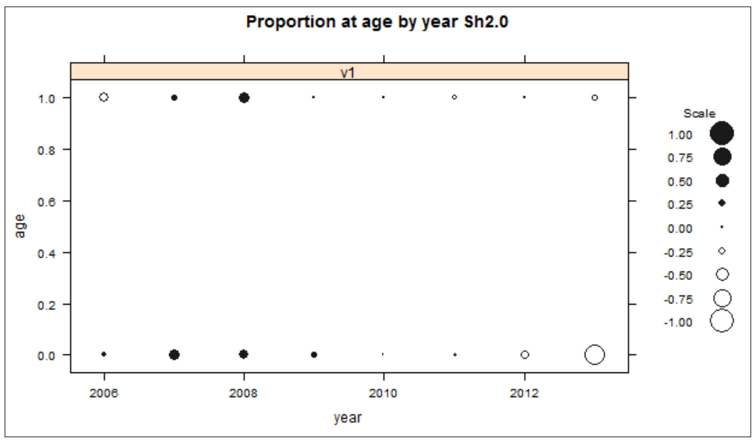


Fig. 4.2.8.6.3.2. Red mullet in GSA 9. Residuals defined with Shr2 option.

Residuals from tuning fleets (MEDITS) per age and year were relatively low and did not show any trend with time

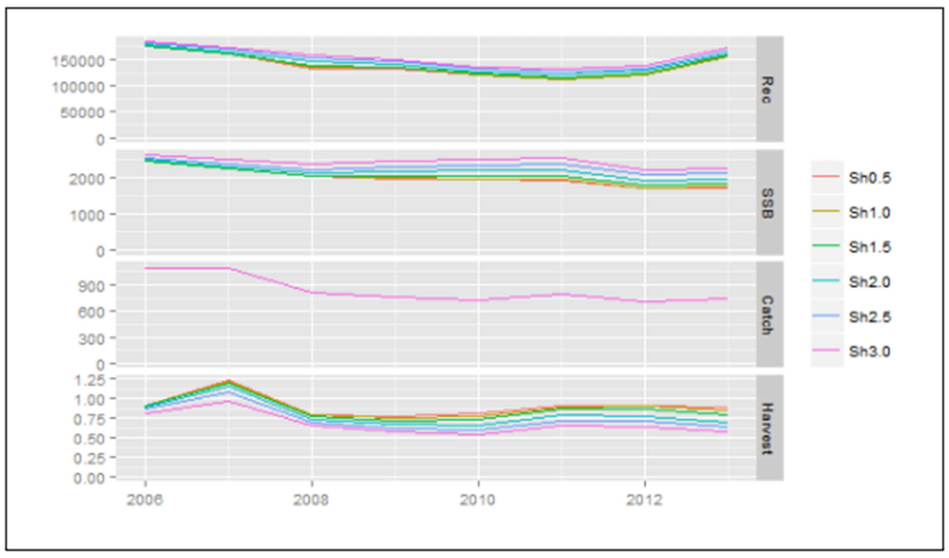


Fig. 4.2.8.6.3.3. Red mullet in GSA 9. Estimates of recruitment, spawning stock biomass and F derived with different years for shrinkage.

Retrospective analysis was carried out and the time series of estimates for assessments terminating in 2012, 2011, 2010 and 2009 are plotted. The retrospective series indicate good agreement between years in the assessment results with no systematic bias. The estimates derived from retrospective assessments are plotted in figure Fig. 4.2.8.6.3.4.

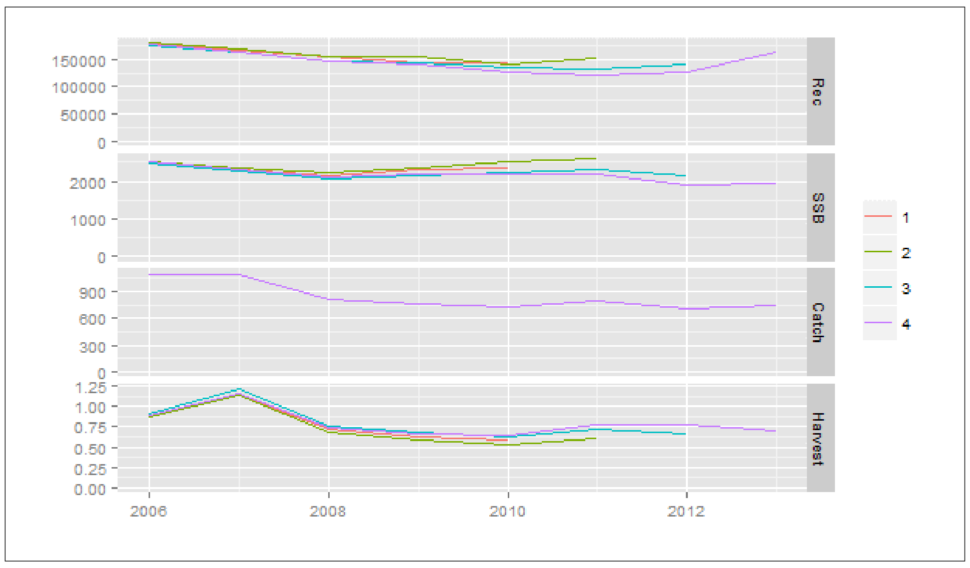


Fig. 4.2.8.6.3.4. Red mullet in GSA 9. Results of the retrospective analysis

The index of stock abundance shows some variability throughout the time series, but no trend is observed in recent years. Fishing mortality has shown a decreasing trend with a peak in 2007.

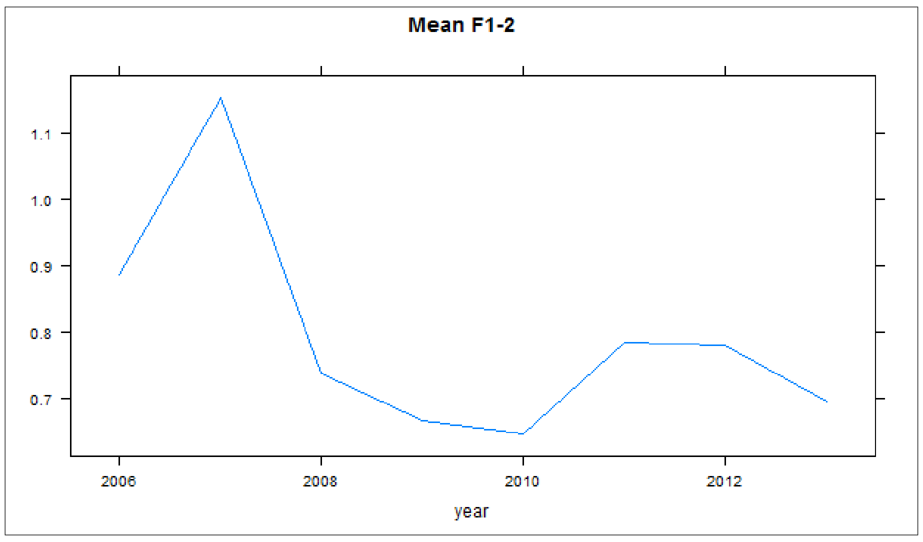


Fig. 4.2.8.6.3.5. Red mullet in GSA 9. Estimated mean F (1-2) by year.

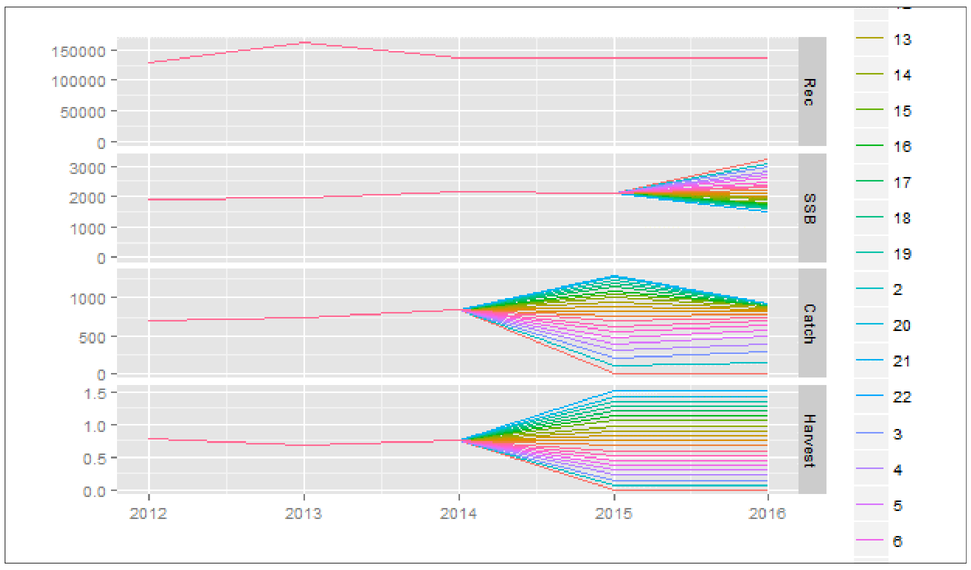


Fig. 4.2.8.6.3.6. Red mullet in GSA 9. Predicted recruitment, Spawning stock biomass, and F for the next 2 years

The XSA package used allowed a Yield per recruit analysis and an estimate of some F-based Reference Points as F_{max} and $F_{0.1}$. Yield per Recruit computation was made by R project software and the FLR libraries. The fishing mortality rate corresponding to $F_{0.1}$ in the yield per recruit curve is considered here as a proxy of $F_{MSY.}$

Table 4.2.8.6.3.1. Red mullet in GSA 9. Main reference Points defined with the Yield per recruit analysis.

Ref.pt	harvest	yield	rec	ssb	biomass	revenue
virgin	0.0000e+00	0.0000e+00	1.0000e+00	4.1502e-02	4.5187e-02	NA
msy	1.1076e+00	6.1702e-03	1.0000e+00	1.1763e-02	1.5448e-02	NA
crash	3.3263e+01	3.1638e-03	1.0000e+00	4.1779e-06	3.6897e-03	NA
f0.1	5.9584e-01	5.7075e-03	1.0000e+00	1.7810e-02	2.1495e-02	NA
Fmax	1.1076e+00	6.1702e-03	1.0000e+00	1.1763e-02	1.5448e-02	NA
spr.30	1.0227e+00	6.1627e-03	1.0000e+00	1.2451e-02	1.6136e-02	NA

Fig. 4.2.8.6.3.7. Red mullet in GSA 9. Yield per recruit curve

With the estimated value for $F_{0.1}$ of about 0.6, the current level of F of about 0.7 is higher, and hence, a status of overexploitation can be assumed.

In a previous analysis using data from 1994 to 2010 for the assessment of the stock status through a Non-equilibrium Surplus Production Model implemented in ASPIC the current F_{MSY} rate was estimated to be 0.606 and F_{2011}=0.687, resulting in F/F_{MSY}=1.13.
In the case of XSA F_{2013} was estimated to be 0.70 and compared with the proxy of F_{MSY} derived from Y/R analysis (F0.1=0.596) the F_{2011}/F_{MSY} rate was 1.17.
F-based Reference Points also resulted very similar to those estimated previously with the Non-equilibrium Surplus Production Analysis using ASPIC.

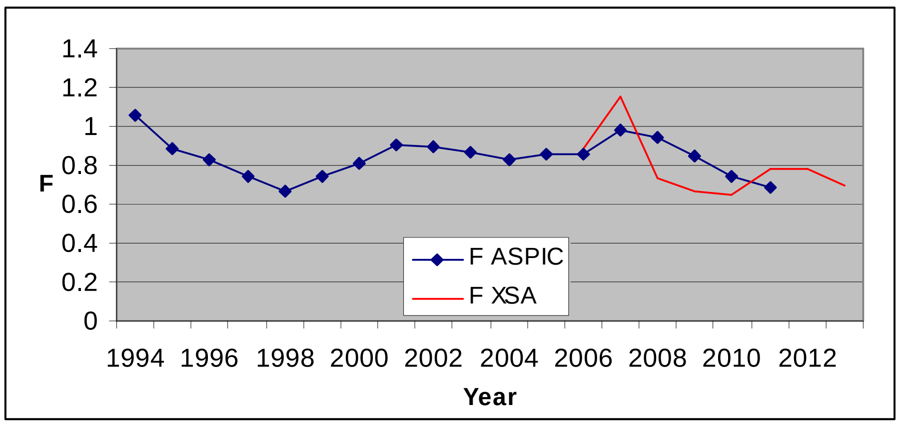


Fig. 4.2.8.6.3.8. Red mullet in GSA 9. Comparison between the F estimates by year derived from XSA and ASPIC along the time series.

In conclusion, we can state that results with these two alternative approaches, based on different data series (catch and effort time series for the two main ports in the GSA 9 combined with surveys abundance time series in the first case, structure of catch by age for the whole GSA 9 and Y/R in the second case) produced almost the same results, both in absolute values and in the perception of the current stock status.

4.2.8.7 Long term prediction

Considering the undefined Stock/Recruitment relationship, it was not possible to perform medium term predictions.

4.2.8.8 Data quality

Exploration of data creates concern with regard the lack of length distributions especially for discards in some years and the presence of frequent inconsistencies along the years and between the reconstructed catch-at-age data and total catches used for the assessment. In any case, the results of the assessment, after the necessary adjustments can be considered representative of the overall trends in the stock and exploitation dynamics. It appears unreliable the trend of catches from the small scale fisheries, which according to official data is 10 times higher in the more recent years. A major attention on sampling schemes and operations of rising to total catch should be given.

4.2.8.9 Scientific advice

4.2.8.9.1 State of the stock size

SSB shows some variability throughout the time series, but no major trend is observed in recent years.

4.2.8.9.2 State of recruitment

Recruitment shows a fairly stable level along the time series, with a slight increase in the more recent year.

4.2.8.9.3 State of exploitation

The species is considered overexploited, with quite consistent estimates of the current fishing mortality obtained with the 2 alternative approaches (XSA and ASPIC) all of them higher than the values considered limit reference points (F_{MSY} =0.60 from Y/R analysis and F_{MSY}=0.60 with the production model).

The current F (0.70) is larger than F_{MSY} (0.60), which indicates that red mullet in GSA 9 is exploited unsustainably.

4.2.8.10 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

It is advisable a reduction of the fishing mortality for the fisheries that target the stock and an improvement of the exploitation pattern, which currently mainly target age 0 individuals. Such combination of exploitation rate and pattern does not allow a sustainable and productive exploitation of the stock.

4.2.9 STOCK ASSESSMENT OF BLUE WHITING IN GSA 9

4.2.9.1 Stock Identification

Due to insufficient information about the stock structure of blue whiting in the western Mediterranean Sea, this stock was assumed to be confined within the boundaries of the GSA 09.

Blue whiting is widely distributed throughout the Mediterranean and thus in all the Italian seas. In the GSA 9, the highest biomasses are found on ephibathyal fishing grounds (200-500m depth) and, generally, it is fished together with Norway lobster. The maximum size of the species as observed in the length frequency distributions collected during MEDITS trawl surveys was 41 cm of total length (TL). Trawl fishery mostly lands specimens ranging from 10 cm to 30 cm. In some areas larger specimens are caught using fixed gear, such as bottom long-lines and nets.The range of length distributions obtained from trawl catches depends on depth; generally young specimens (9-10 cm TL) are almost exclusively found between 100 m and 200 m. Larger specimens (two or more years old TL>23cm) are instead caught at depths below 200 m (Orsi Relini and Peirano, 1983,1985). Blue whiting is a carnivorous species, prey mostly upon pelagic crustaceans (Brian, 1931), but juveniles of pelagic fish species can also be part of its food spectrum (Bini, 1970).

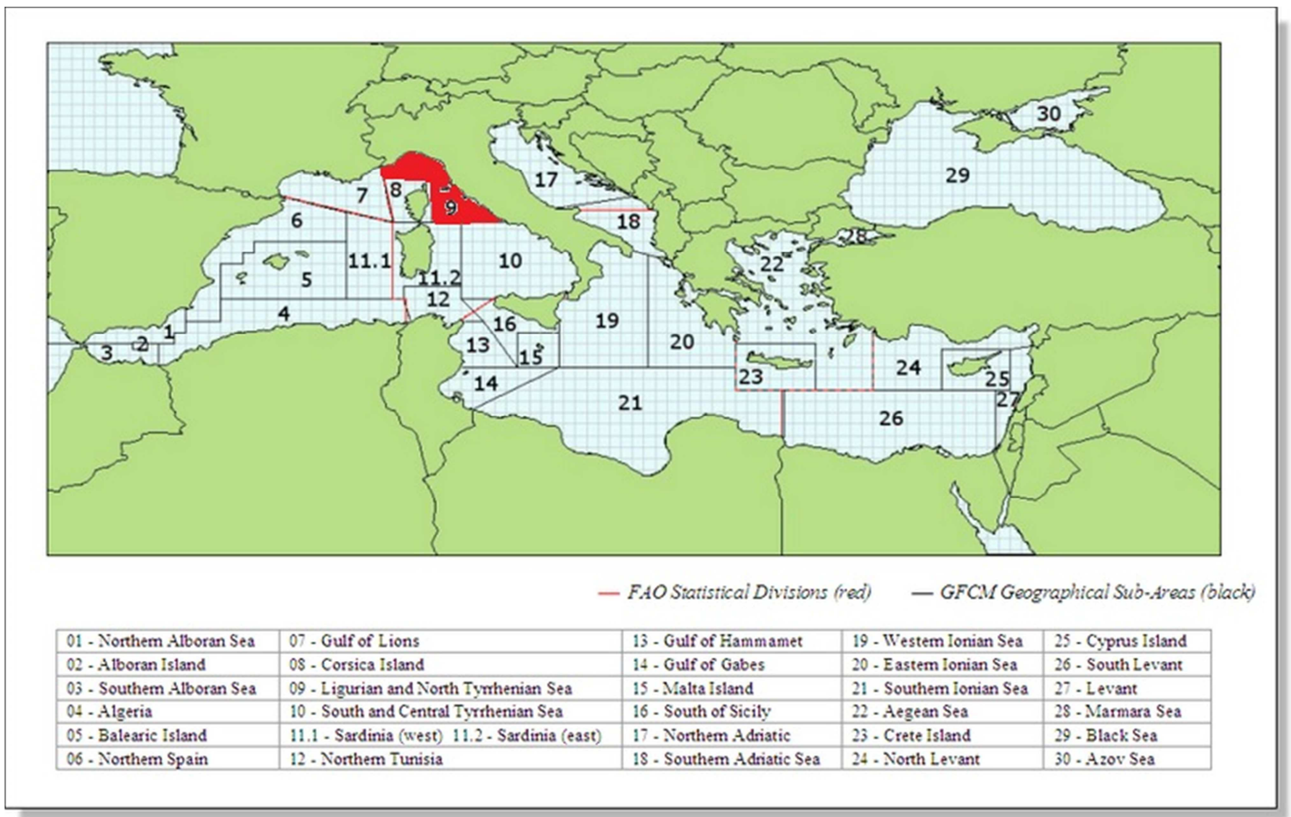


Fig. 4.2.9.1.1. Geographical location of GSA 9.

4.2.9.2 Growth

The growth of blue whiting was analysed by means of different methods (otolith readings; Orsi Relini and Peirano, 1983 and 1985; modal progression analysis (MPA); GSA 9 GRUND

National Trawl Survey Report). The parameters of the Von Bertalanffy growth curve estimated with different methods are listed in table 4.2.9.2.1. In Fig. 4.2.9.2.1 is showed the growth function choosen and in table 4.2.9.2.2 the parameters of length weight relationships.

Table 4.2.9.2.1. Blue whiting in GSA 9. Von Bertalanffy parameters.

References	Method	Sex	L_∞	k	t_0
Orsi Relini and Peirano (1985)	Otoliths	M	40.48	0.231	-1.27
Orsi Relini and Peirano (1985)	Otoliths	F	48.37	0.189	-1.23
GSA 9 (2003)	MPA	M+F	45.25	0.350	0.00

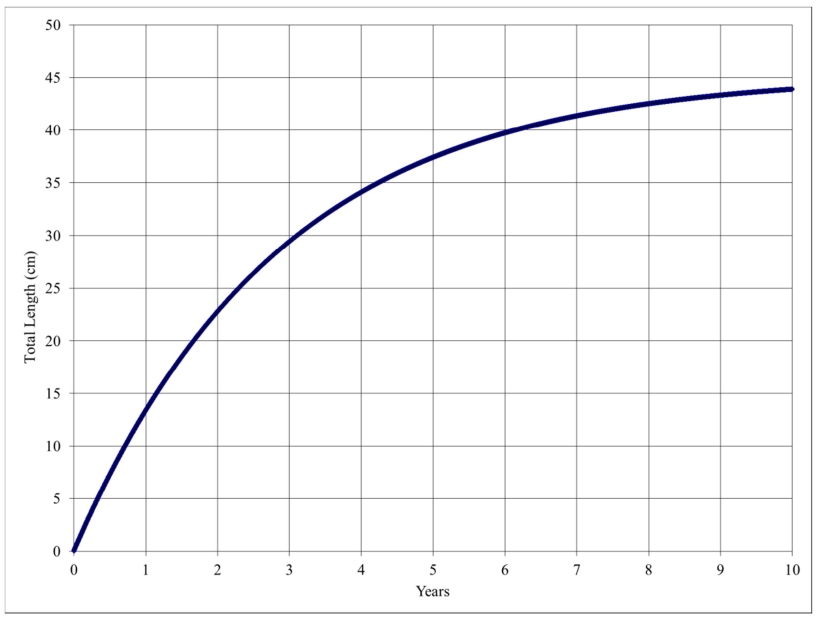


Fig 4.2.9.2.1. Blue whiting in GSA 9. Von Bertalanffy curve used in the analysis (L_{inf}=45.25, k=0.350,t_0=0).

Table 4.2.9.2.2. Blue whiting in GSA 9. Length-weight relationship parameters.

References	Sex	a	b
GSA09 (2003)	M+F	0.004	3.154

4.2.9.3 Maturity

The spawning season of blue whiting is restricted to the winter months (January to April). In the Ligurian Sea, the age of first maturity is two years (around 22 cm) (Orsi Relini and Peirano, 1983 and 1985) In the Northern Tyrrhenian Sea, the maximum value of the gonodosomatic index (G.S.I; gonad weight*100/gutted weight) calculated for spawning female was 6.06 (± 3.59) (Chiericoni *et al.*, 1996).

4.2.9.4 Fisheries

4.2.9.4.1 General description of Fisheries

In the GSA 9, blue whiting is exploited mainly with otter bottom trawling (OTB) and is a by-catch species of the fishery carried out on the muddy bottoms of the upper slope and it is typically caught together with Norway lobster. Economic value is very low in the southern part of the area about 0.5euro a kg while is more appreciated in the northern part with 2-3 euros a kg.

4.2.9.4.2 Management regulations applicable in 2009-2013

EC regulation 1967/2006 does not provide for a minimum landing size for this species.

4.2.9.4.3 Catches

Trawl fishery mostly caught specimens ranging from age 1 to age 3 and, in term of length, ranging from 16 cm to 30 cm. The maximum size of the species as observed in the catch length frequency distributions collected was 39 cm of total length (TL). The age/length structures of the catches, according to the EU Data Collection Framework (DCF) data, is shown in Fig.4.2.9.4.3.1 and 4.2.9.4.3.2.

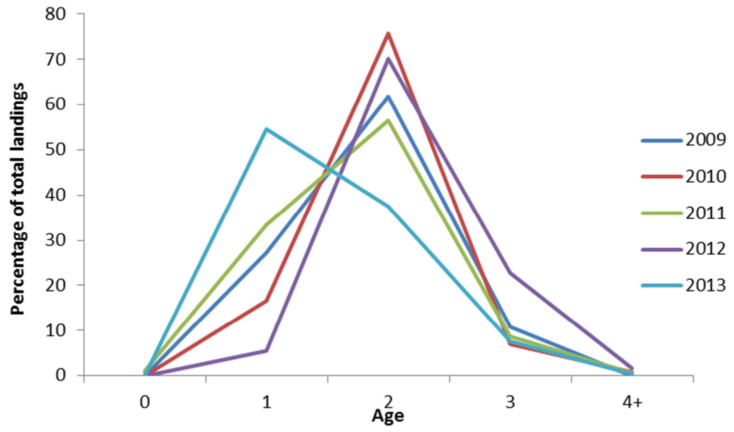


Fig.4.2.9.4.3.1. Blue whiting in GSA 9. Age frequency distributions (in percentage) of catches from 2009 to 2013.

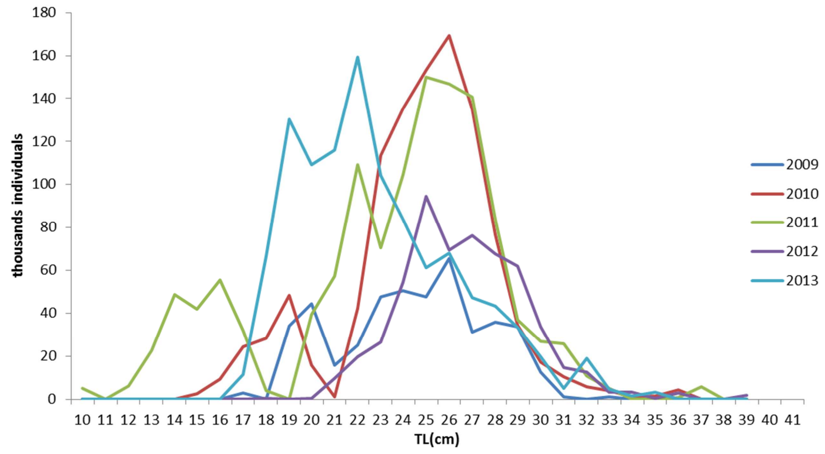


Fig. 4.2.9.4.3.2. Blue whiting in GSA 9. Length frequency distributions (in percentage) of catches from 2009 to 2013.

4.2.9.4.4 Landings

The landings are almost entirely taken by the OTB fleet. Total landings of blue whiting based on DCF remained rather stable in the last five years with a mean value of about 106 t (Fig. 4.2.9.4.4.1; Tab. 4.2.9.4.4.1) despite this, seasonal fluctuations are a proper characteristic of the landings of this species, as shown by the landings per unit of effort (LPUE in kg/boat/day) estimated for the fleet of Santa Margherita Ligure in the period 1987-1996 and in more recently years (2009-2010 and 2011-2012) (Fig. 4.2.9.4.4.2 and Fig. 4.2.9.4.4.3) (Mannini pers.comm.). LPUE (kg/boat/day) mean values decrease in time from about 12 to 2.5 kg/boat/day. This decreasing is due to local market request and could be due also to changes in water temperature (increasing in water temperature are not suitable for this “cold” species).

Fig. 4.2.9.4.4.1. Blue whiting in GSA 9. Total landings by gear.

Tab. 4.2.9.4.4.1. Blue whiting in GSA 9. Annual landings (t) by fishing technique as provided through the official DCF data call in 2014.

Country	Area	Year	Gear	Species code	Landings (t)
ITA	GSA9	2009	OTB	WHB	116.836
ITA	GSA9	2009	GNS	WHB	0.292
ITA	GSA9	2010	OTB	WHB	114.407
ITA	GSA9	2010	GNS	WHB	0.507
ITA	GSA9	2010	GTR	WHB	0.233
ITA	GSA9	2011	OTB	WHB	121.373
ITA	GSA9	2011	GNS	WHB	0.123
ITA	GSA9	2011	GTR	WHB	0.755
ITA	GSA9	2012	OTB	WHB	77.022
ITA	GSA9	2012	GNS	WHB	1.040
ITA	GSA9	2012	GTR	WHB	0.341
ITA	GSA9	2013	OTB	WHB	100.099
ITA	GSA9	2013	GNS	WHB	1.851
ITA	GSA9	2013	GTR	WHB	0.082

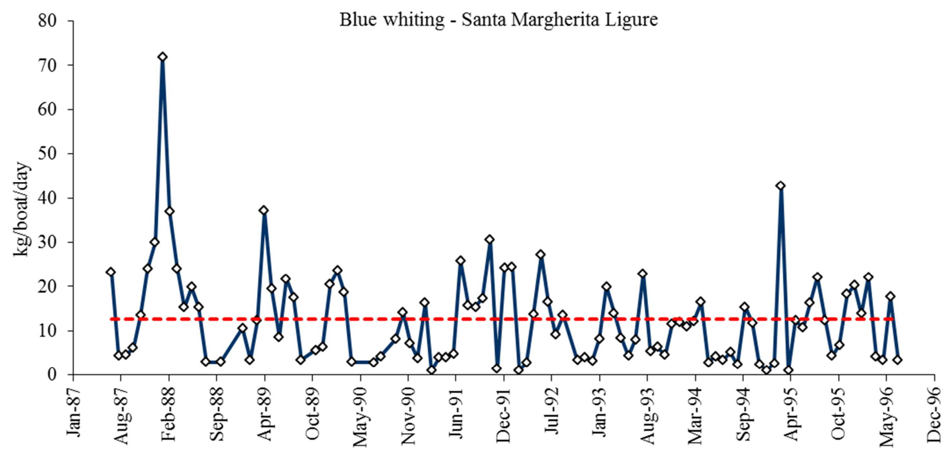
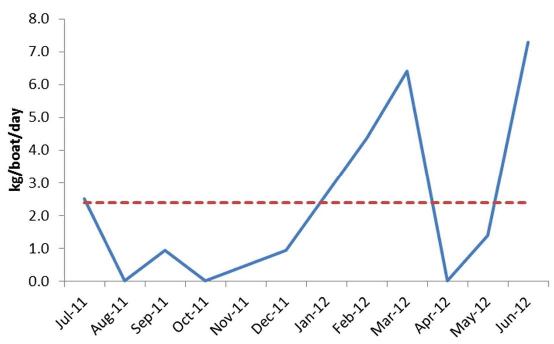


Fig. 4.2.9.4.4.2 Blue whiting in GSA 9. Time series of LPUE (kg/boat/day) from Santa Margherita Ligure from July 1987 to October 1996 (red dashed line is the mean of the period).



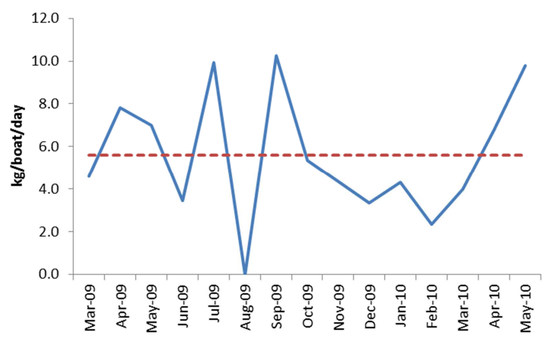


Fig. 4.2.9.4.4.3. Blue whiting in GSA 9. Time series of LPUE (kg/boat/day) from Santa Margherita Ligure from March 2009 to May 2010 and from July 2011 and June 2012 (red dashed line is the mean of the period).

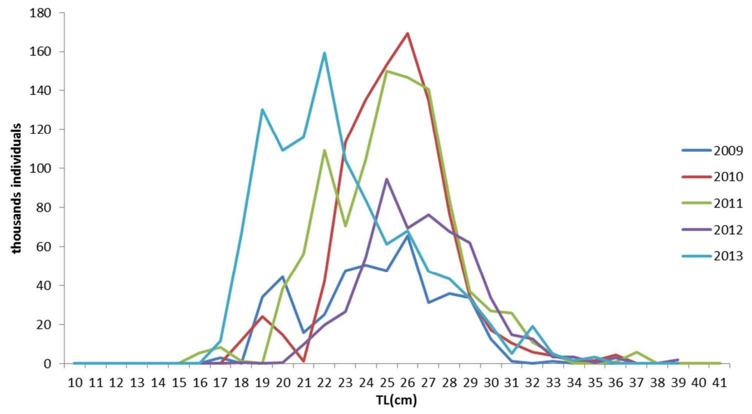


Fig. 4.2.9.4.4.4. Blue whiting in GSA 9. Length frequency distributions (in percentage) of landings from 2009 to 2013.

4.2.9.4.5 Discards

Blue whiting discards are very low and mainly represented by young specimens even if, depending on the market demand, in some cases also bigger ones are discarded. In table 4.2.9.4.5.1 are reported discards values and percentage respect to the total catches and in Fig. 4.2.9.4.5.1 the corresponding length structures.

Table 4.2.9.4.5.1. Blue whiting in GSA 9. Discards values and percentage respect to the total catches.

Country	Area	Year	Gear	Species	Landings (t)	Discards (t)	% Discards on total catches
ITA	SA9	2010	OTB	WHB	115.1	3.1	2.7
ITA	SA9	2011	OTB	WHB	122.3	5.7	4.4

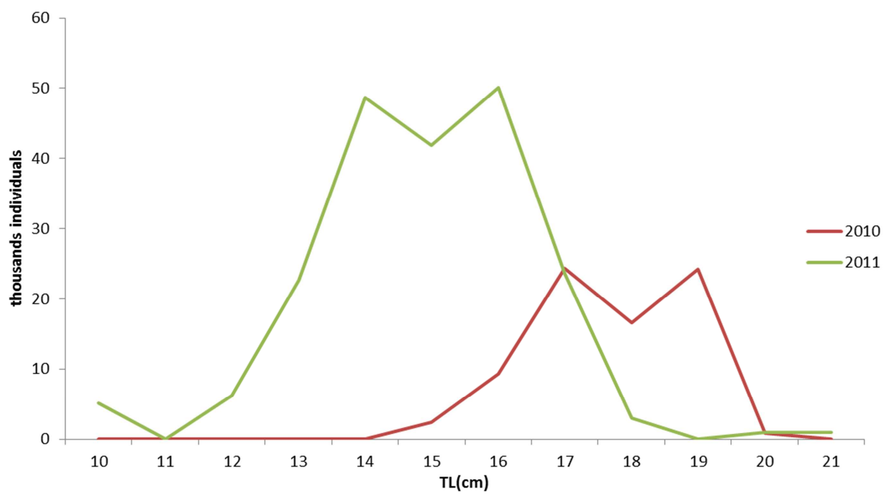


Fig. 4.2.9.4.5.1. Blue whiting in GSA 9. Length frequency distributions (in percentage) of discards in 2010 and 2011.

4.2.9.4.6 Fishing Effort

The fishing effort by fishing technique is listed in Tab. 4.2.9.4.6.1. A decreasing trend is recognizable from 2004 until 2013 (Fig. 4.2.9.4.6.1).

Tab. 4.2.9.4.6.1. Trends in annual fishing effort expressed as nominal effort (kW·days) and GT·days at sea deployed in GSA 09 from 2004 to 2013.

Country	Area	Year	Gear	Nominal effort	GT days at sea
ITA	SA9	2004	OTB	14820339	2460274
ITA	SA9	2005	OTB	14700599	2423342
ITA	SA9	2006	OTB	12404787	2226848
ITA	SA9	2007	OTB	12782144	2167545
ITA	SA9	2008	OTB	10693694	1888655
ITA	SA9	2009	OTB	12176447	2030916
ITA	SA9	2010	OTB	11228001	1910812
ITA	SA9	2011	OTB	10696166	1837137
ITA	SA9	2012	OTB	9997907	1891882
ITA	SA9	2013	OTB	10724881	1939445

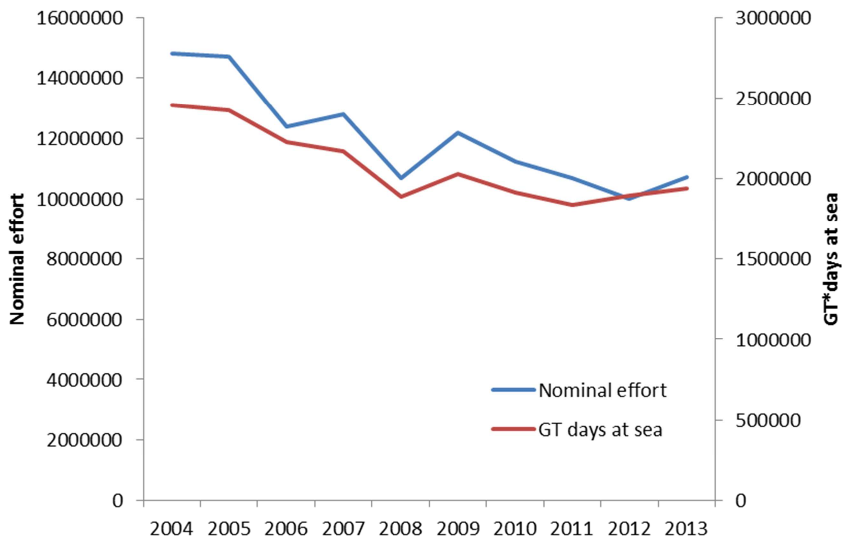


Fig. 4.2.9.4.6.1. Trends in OTB annual fishing effort expressed as nominal effort (kw·days) and GT·days at sea deployed in GSA 9 from 2004 to 2013.

4.2.9.5 Scientific surveys

4.2.9.5.1 Methods

Since 1994 MEDITS trawl surveys has been regularly carried out each year during the spring season.

Based on the DCF data, abundance and biomass indices were recalculated. In GSA 9 the following number of hauls was reported per depth stratum (Tab. 4.2.9.5.1.1).

Tab. 4.2.9.5.1.1. Number of hauls per year and depth stratum in GSA 9, 1994-2013.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GSA09 010-050	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16
GSA09 050-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17
GSA09 100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30
GSA09 200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35
GSA09 500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations in each stratum. Aggregated length frequencies were then raised to stratum abundance 100 (because of the low numbers in most strata) and finally aggregated (sum) over the strata of the entire GSA.

4.2.9.5.2 Geographical distribution patterns

The stock is present in the whole area but is more abundant in the northern part of the GSA 9 (Ligurian Sea) as showed in Fig. 4.2.9.5.2.1

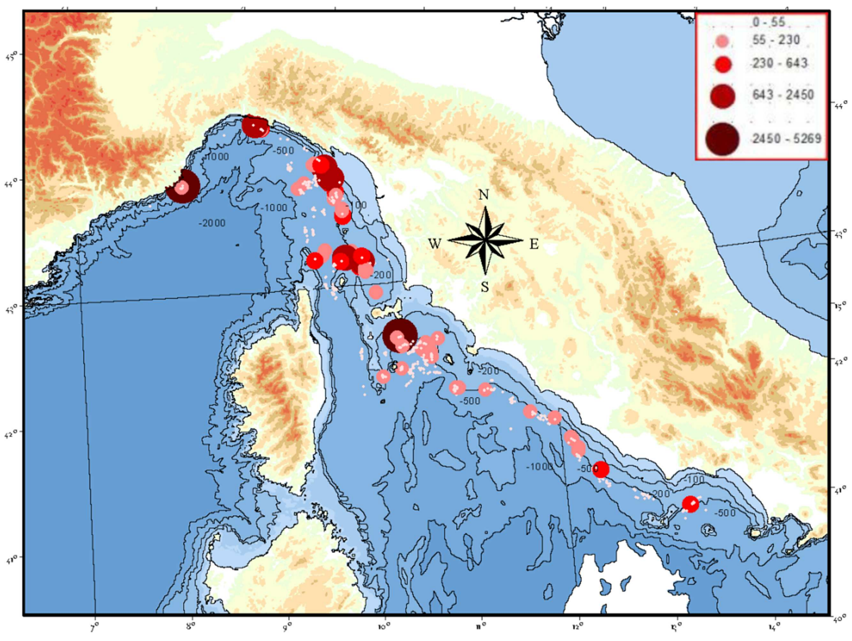


Fig. 4.2.9.5.2.1. Blue whiting in GSA 9. Biomass (kg/km^2) indexes by hauls (Medits 1994-2013).

4.2.9.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of blue whiting in GSA 9 was derived from the international survey MEDITS. Figure 4.2.9.5.3.1 displays the estimated trend in *M. poutassou* abundance and biomass in GSA 9. The estimated abundance and biomass indices do not reveal a clear trend but a series of peaks followed by quite stable situations. (Fig. 4.2.9.5.3.1).

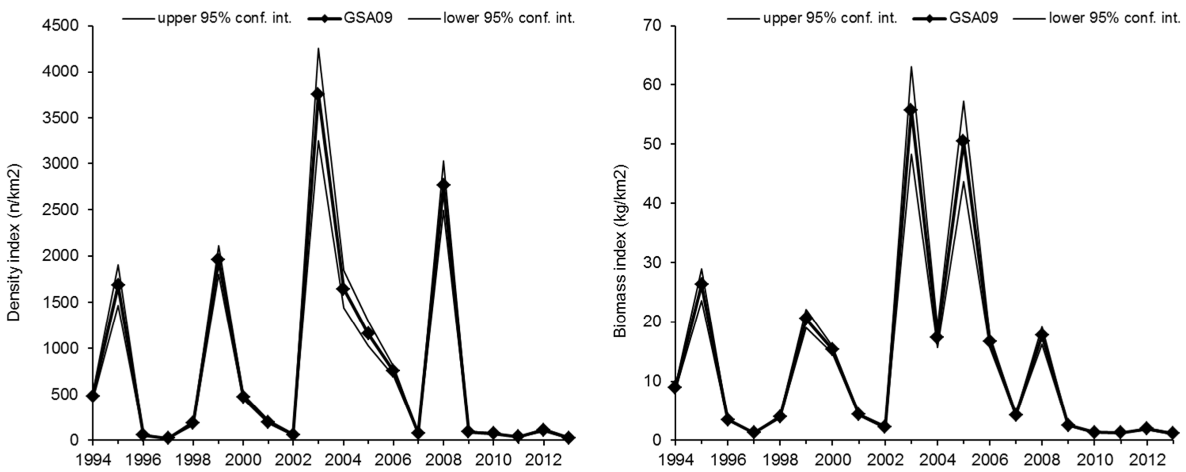


Fig. 4.2.9.5.3.1. Blue whiting in GSA 9. Medits standardized abundance and biomass indices (10-800m).

4.2.9.5.4 Trends in abundance by length or age

The following Figures 4.2.9.5.4.1 - 3 display the stratified abundance indices of GSA 9 in 1994-2013.

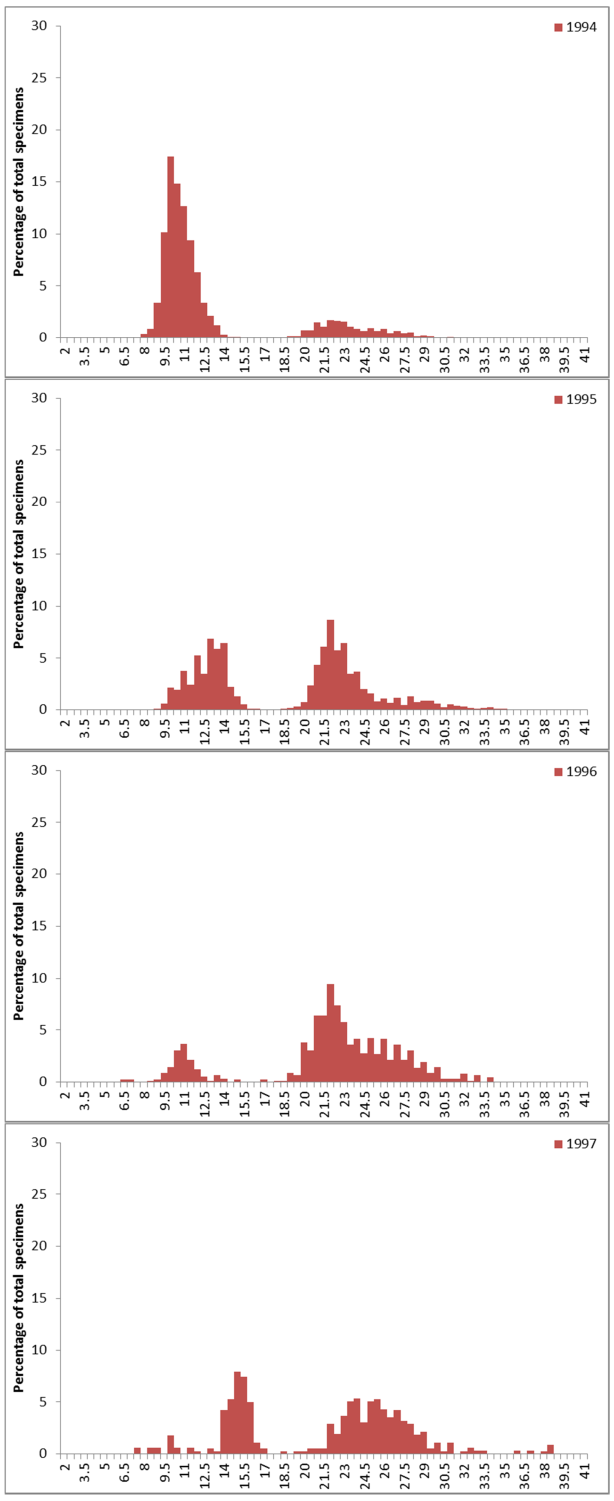
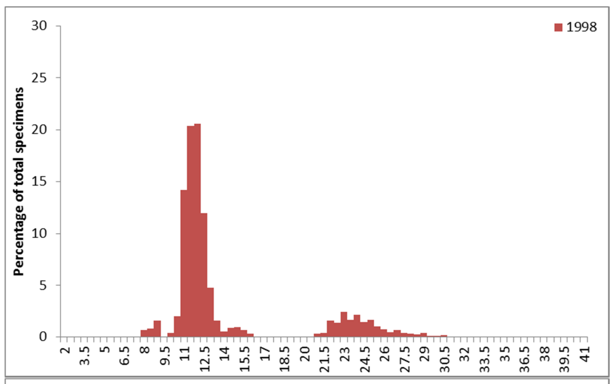
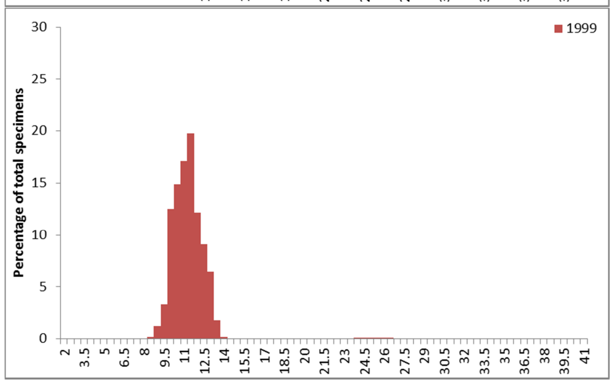
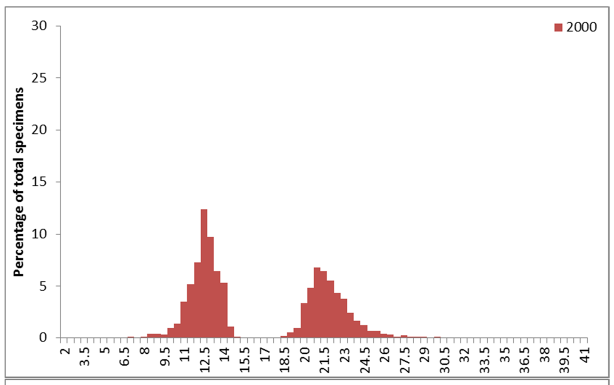
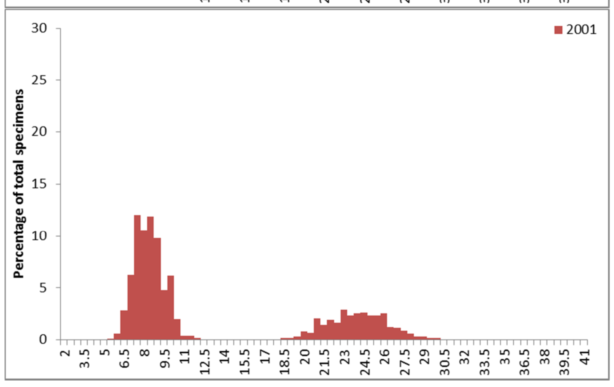


Fig. 4.2.9.5.4.1. Blue whiting in GSA 9. MEDITS stratified (10-800m depth) abundance indices by size in percentage (years 1994-1997).


1998
Percentage of total specimens


1999
Percentage of total specimens


2000
Percentage of total specimens


2001
Percentage of total specimens

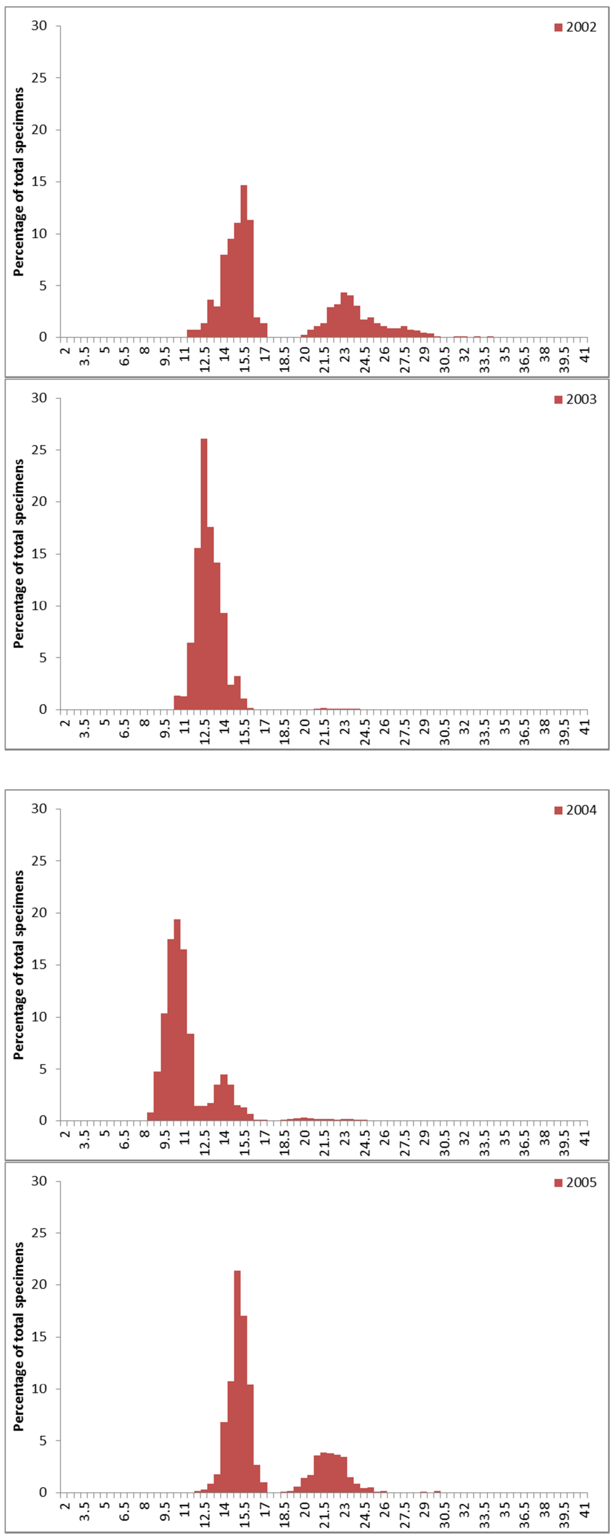
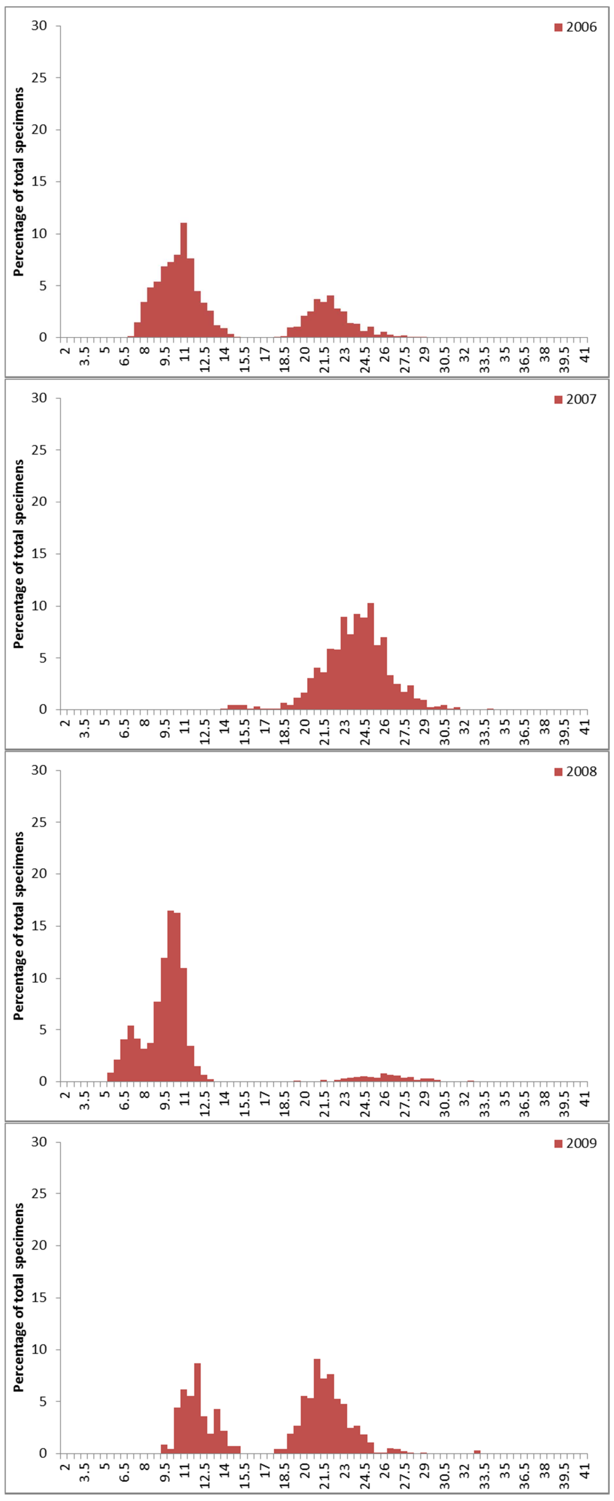


Fig. 4.2.9.5.4.2. Blue whiting in GSA 9. MEDITS stratified (10-800m depth) abundance indices by size in percentage (years 1998-2005).


2006
2007
2008
2009
Percentage of total specimens
0 5 10 15 20 25 30
2 3.5 5 6.5 8 9.5 11 12.5 14 15.5 17 18.5 20 21.5 23 24.5 26 27.5 29 30.5 32 33.5 35 36.5 38 39.5 41

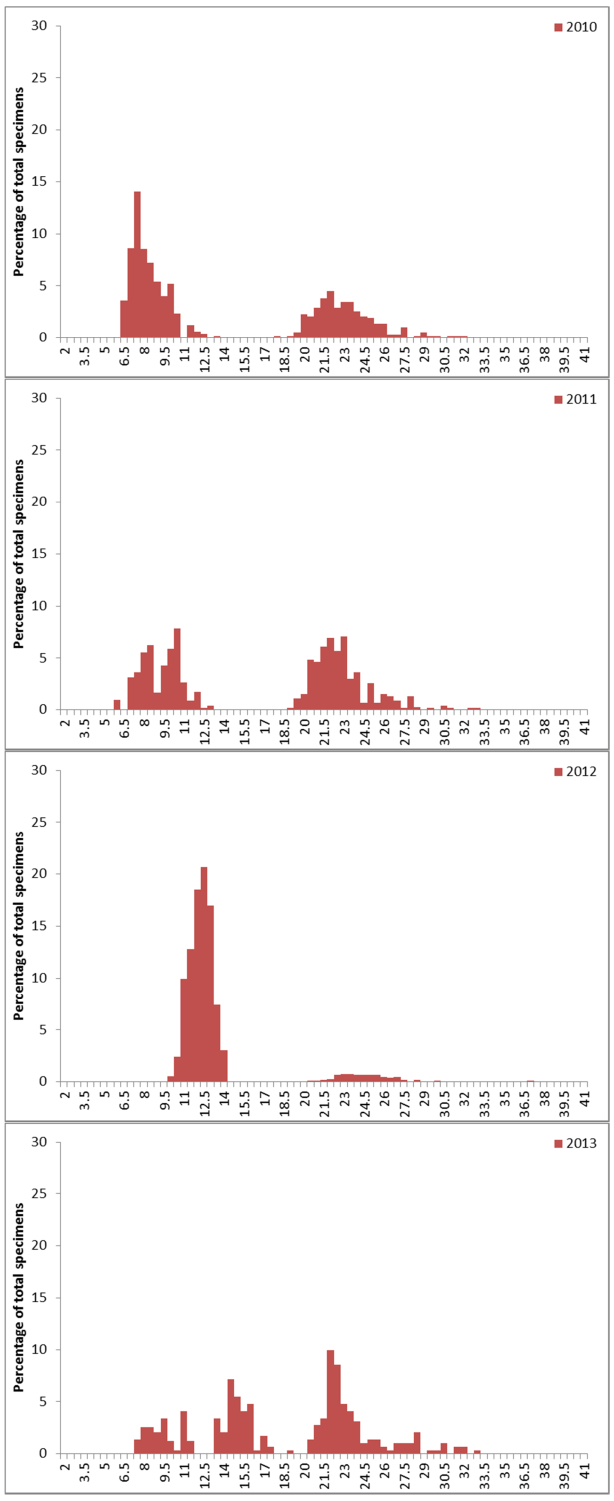


Fig. 4.2.9.5.4.3. Blue whiting in GSA 9. MEDITS stratified (10-800m depth) abundance indices by size in percentage (years 2006-2013).

The boxplot of the MEDITS length frequencies distributions (LFDs) is shown in Fig. 4.2.9.5.4.4. It is evident a high variability in the LFD and in some years it is also evident the presence of recruits.

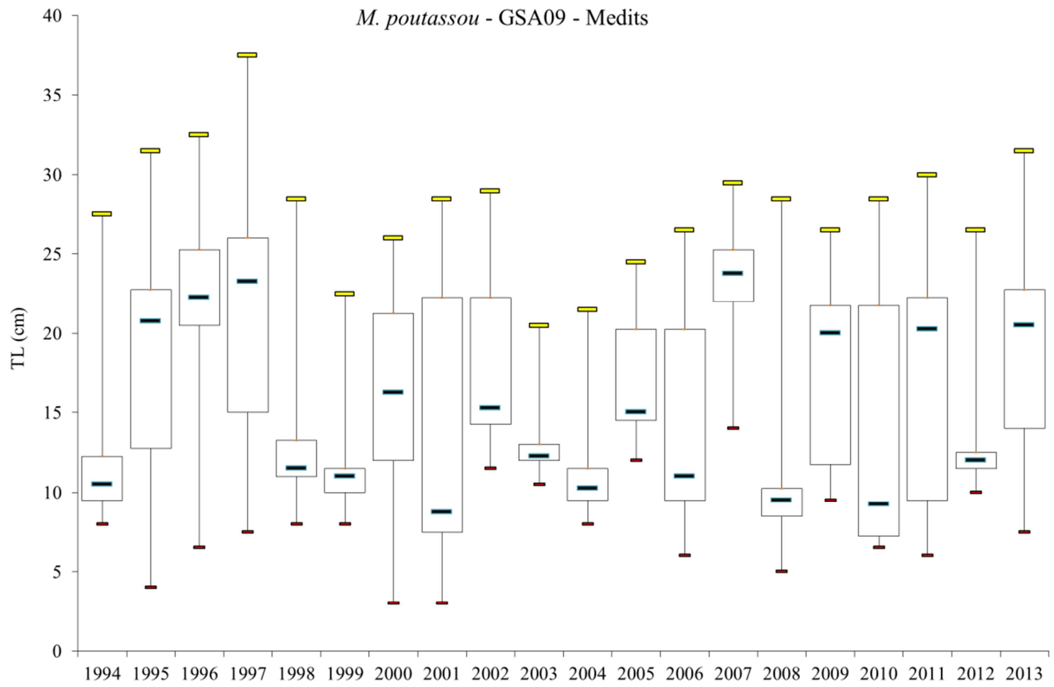


Fig. 4.2.9.5.4.4. Blue whiting in GSA 9. Boxplot of the length frequency distributions of blue whiting in GSA 9 obtained in the MEDITS surveys.

4.2.9.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.9.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.9.6 Assessment of historic stock parameters

4.2.9.6.1 Method 1: XSA

4.2.9.6.2 Justification

The length of the data series available (5 years, from 2009 to 2013) together with the availability of data from MEDITS survey allowed the use of a VPA (XSA) tuned.

4.2.9.6.3 Input parameters

Data from DCF provided at EWG-14-09 contained information on blue whiting landings and the respective age structure for 2009-2013. Plus group was set at age 4. The number of individuals by age was SOP corrected [SOP = Landings / Σ*a* (total catch numbers at age *a* x catch weight-at-age *a*)].

Tab. 4.2.9.6.3.1. Blue whiting in GSA 9. Sum of product correction factor (SOP) .

	2009	2010	2011	2012	2013
SOP correction factor	0.41	0.97	0.96	0.95	1.02

The very high SOP correction factor in the 2009 was due to the fact that the landings were from two different métiers OTB_DES and OTB_MDD, but only for OTB_MDD samples were available. So, the raising was computed only considering the landings of this métier and not to the whole cacthes.

Biological parameters are listed in Tab. 4.2.9.6.3.2 and data used are reported in Tab. 4.2.9.6.3.3. A natural mortality vector computed using ProdBiom (Abella, 1998) was used. Survey standardized length frequency distributions were splitted in age classes (up to the age class 4+) by LFDA. Analysis was performed by sex combined. Given that the landings were composed mainly of individuals between 1 and 3 years, these ages were selected as the Fbar.

Tab. 4.2.9.6.3.2. Blue whiting in GSA 9. Biological parameters.

	Growth (GSA9)	Length-Weight relationships (GSA9)
Sex combined	L_∞ = 45.25 cm TL k = 0.35 t_0 = 0	a = 0.004 b = 3.154

Tab. 4.2.9.6.3.3. Blue whiting in GSA 9. Input parameters for the XSA.

Catch at age	0	1	2	3	4+
2009	0.002	301.521	685.382	120.337	0.002
2010	0.001	177.995	810.252	74.584	7.196
2011	11.887	430.166	729.240	110.641	6.822
2012	0.001	32.323	409.856	132.910	9.050
2013	0.001	583.770	401.298	80.751	4.710

Catch Weigth at age	0	1	2	3	4+
2009	0.011	0.059	0.114	0.175	0.298
2010	0.011	0.053	0.115	0.185	0.301
2011	0.011	0.042	0.119	0.186	0.328
2012	0.011	0.071	0.120	0.183	0.280
2013	0.011	0.067	0.115	0.191	0.282

Stock Weigth at age	0	1	2	3	4+
2009	0.011	0.059	0.114	0.175	0.298
2010	0.011	0.053	0.115	0.185	0.301

2011	0.011	0.042	0.119	0.186	0.328
2012	0.011	0.071	0.120	0.183	0.280
2013	0.011	0.067	0.115	0.191	0.282

Natural mortality at age	**0**	**1**	**2**	**3**	**4+**
2009	1.07	0.61	0.44	0.37	0.34
2010	1.07	0.61	0.44	0.37	0.34
2011	1.07	0.61	0.44	0.37	0.34
2012	1.07	0.61	0.44	0.37	0.34
2013	1.07	0.61	0.44	0.37	0.34

Proportion of mature at age	**0**	**1**	**2**	**3**	**4+**
2009	0	0.4	0.8	1	1
2010	0	0.4	0.8	1	1
2011	0	0.4	0.8	1	1
2012	0	0.4	0.8	1	1
2013	0	0.4	0.8	1	1

Tuning (Medits)		**0**	**1**	**2**	**3**	**4+**
2009	1	21.851	36.378	11.868	0.214	0.001
2010	1	27.782	8.246	8.987	0.431	0.001
2011	1	17.255	11.01	9.707	0.487	0.001
2012	1	85.698	18.173	6.784	0.223	0.102
2013	1	4.068	11.358	5.57	0.742	0.001

Year	Catch
2009	117.13
2010	118.29
2011	127.93
2012	78.40
2013	102.03

4.2.9.6.4 Results

Different sensitivity analyses were performed before running the final XSA. The first sensitivity analysis tested different shrinkage weights (1.0, 1.5, 2.0, 2.5 and 3.0); since the analysis of the residuals show better situation for Sh3.0 (Fig. 4.2.9.6.4.1), the higher option was chosen. The second sensitivity analysis tested different shrinkage ages (1, 2 and 3) using shrinkage weight of 3.0. Since the best residuals pattern was obtained with age 3.0 this option was selected (Fig. 4.2.9.6.4.2).

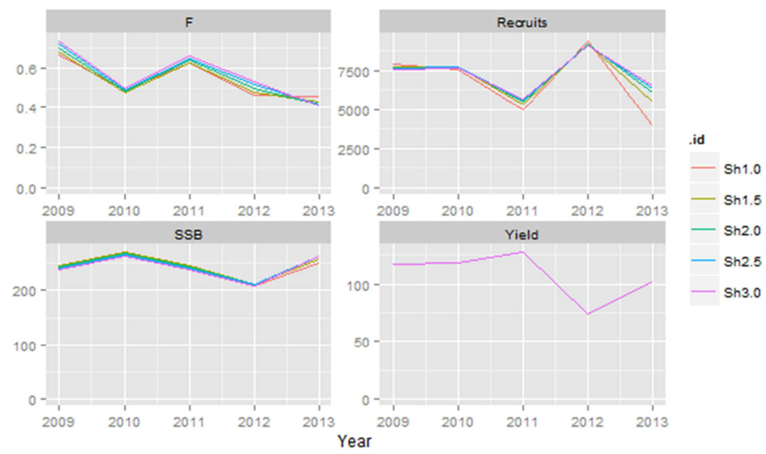


Fig. 4.2.9.6.4.1. Blue whiting in GSA 9. XSA outputs for different shrinkage scenario and log residuals for the tuning fleet.

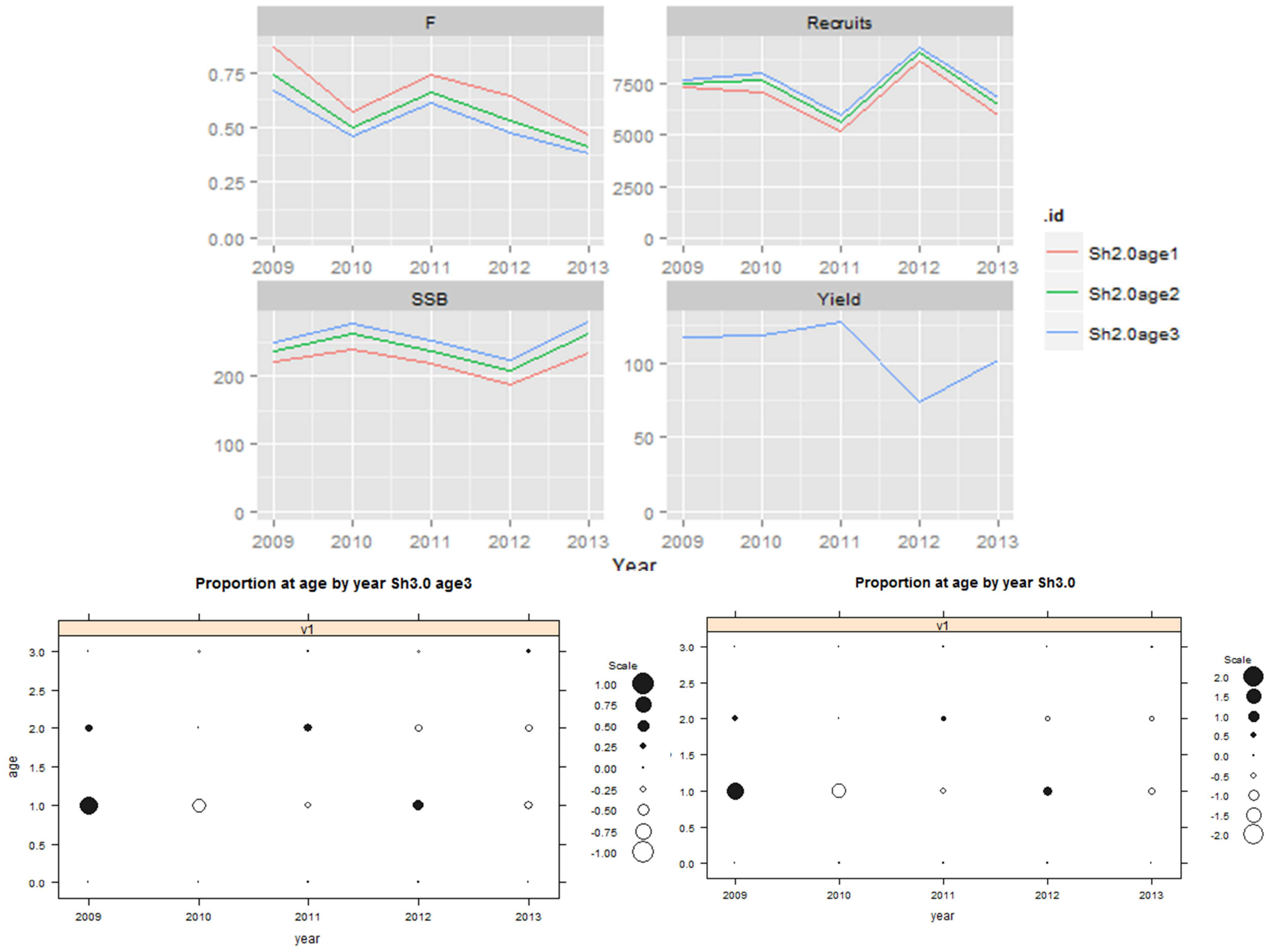


Fig. 4.2.9.6.4.2. Blue whiting in GSA 9. XSA outputs for different shrinkage ages scenario and log residuals for the tuning fleet.

Based on these simulation analyses, the following inputs were selected to run the final XSA:

fse	rage	qage	shk.n	shk.f	shk,yrs	Shk.ages
3.0	1.0	3.0	true	true	1.0	3.0

Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 1 to - 1, and did not show any trend with time (Fig. 4.2.9.6.4.2). XSA main outputs (Fig. 4.2.9.6.4.3) showed a decrease in fishing mortality, from about 0.6 to 0.4. Both SSB and recruits showed low variations around mean value of the last five years with respectively about 257 (t) and 7613 (10^3) values. XSA stock summary results are reported in the table 4.2.9.6.4.1.

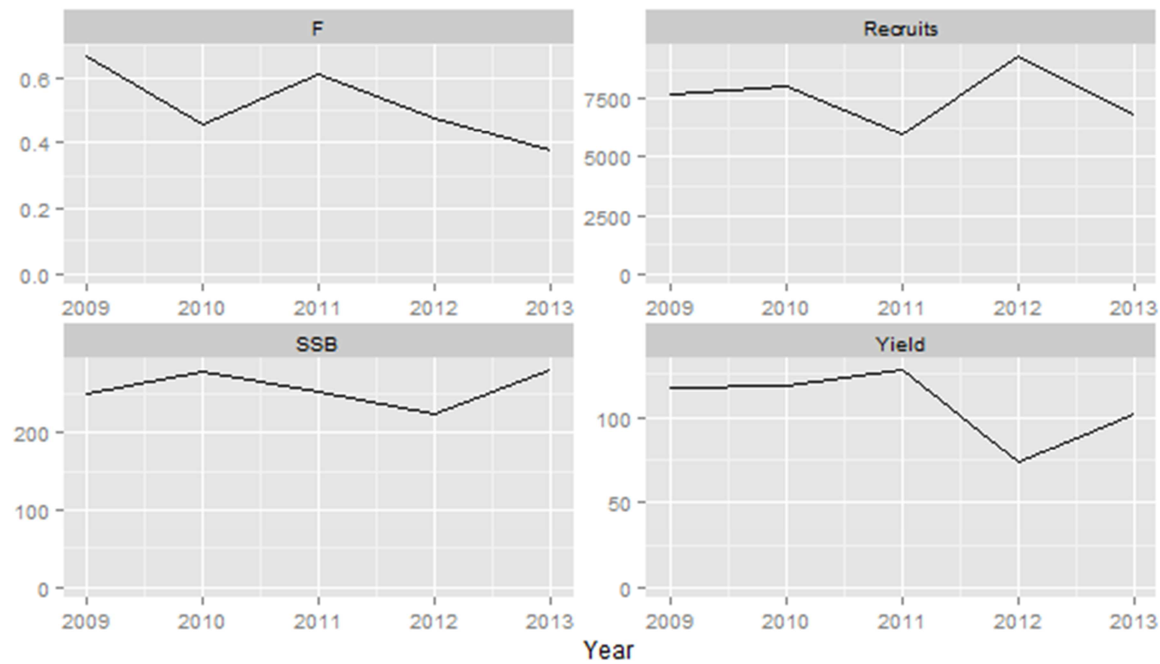


Fig. 4.2.9.6.4.3. Blue whiting in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

The XSA diagnostics are reported below:

FLR XSA Diagnostics 2014-07-16 12:44:53

CPUE data from indices

Catch data for 5 years 2009 to 2013. Ages 0 to 4.

	fleet	first age	last age	first year	last year	alpha	beta
1	Medits	0	3	2009	2013	<NA>	<NA>

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of size for ages > 1

Catchability independent of age for ages > 3

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 2 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 3

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

year					
age	2009	2010	2011	2012	2013
all	0.976	0.99	0.997	1	1

Fishing mortalities

year					
age	2009	2010	2011	2012	2013
0	0.000	0.000	0.003	0.000	0.000
1	0.129	0.096	0.236	0.020	0.283
2	0.952	0.979	1.186	0.518	0.612
3	0.922	0.300	0.416	0.881	0.239
4	0.922	0.300	0.416	0.881	0.239

XSA population number (Thousand)

age					
year	0	1	2	3	4
2009	7725	3385	1391	240	0
2010	8092	2650	1617	346	33

2011 6003 2776 1308 391 24
2012 9364 2052 1191 257 17
2013 6884 3212 1093 457 26

Estimated population abundance at 1st Jan 2014

	age				
year	0	1	2	3	4
2014	2377	2377	1319	387	251

Fleet: Medits

Log catchability residuals.

	year				
age	2009	2010	2011	2012	2013
0	-0.003	-0.001	0.041	0.020	-0.057
1	0.911	-0.723	-0.297	0.508	-0.385
2	0.363	-0.049	0.367	-0.310	-0.362
3	-0.020	-0.068	0.003	-0.072	0.156

Regression statistics
Ages with q dependent on year class strength
[1] "0.216985665953912" "1.12627429036549" "8.12618125864588" "4.36932572770092"

Terminal year survivor and F summaries:

,Age 0 Year class =2013

source	scaledWts	survivors	yrcls
Medits	0.299	1817	2013
fshk	0.003	0	2013
nshk	0.698	2771	2013

,Age 1 Year class =2012

source	scaledWts	survivors	yrcls
Medits	0.919	934	2012
fshk	0.081	3078	2012

,Age 2 Year class =2011

```
source
     scaledWts survivors yrcls
Medits     0.97      266  2011
fshk       0.03      231  2011
```

,Age 3 Year class =2010

```
source
     scaledWts survivors yrcls
Medits    0.987      290  2010
fshk      0.013      190  2010
```

Table 4.2.9.6.4.1. Blue whiting in GSA 9. XSA stock summary results.

Year	Populations numbers	Recruitment numbers	Populations weight	SSB	F_{bar}(1-3)
2009	12741.2	7724.8	484.18	249.15	0.67
2010	12737.1	8091.8	485.98	278.07	0.46
2011	10502.0	6003.2	417.86	252.02	0.61
2012	12881.4	9363.8	440.88	224.41	0.47
2013	11671.2	6883.6	510.26	281.31	**0.38**

4.2.9.7 Long term prediction

4.2.9.7.1 Justification

The yield per recruit (YpR) analysis was run using FLBRP routine.

4.2.9.7.2 Input parameters

Analysis was computed by sex combined using the same input parameters used for XSA.

4.2.9.7.3 Results

YpR output curve is illustrated in the Figure 4.2.9.7.3.1 while in Table 4.2.9.7.3.1 are reported the main results analysis.

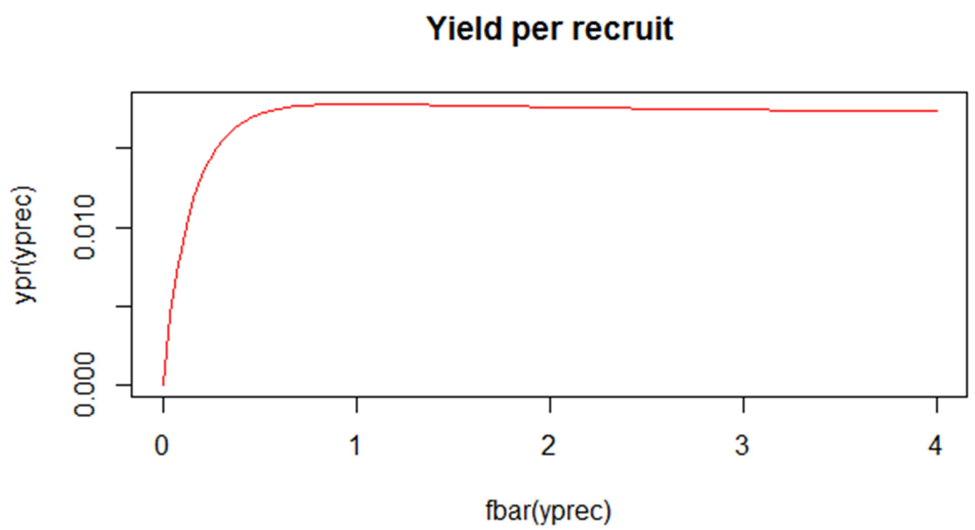


Fig. 4.2.9.7.3.1. Blue whiting in GSA 9. Yield per Recruit curve.

Table 4.2.9.7.3.1. Blue whiting in GSA 9. Summary results of the Yield per recruit analysis.

Reference points	Harvest	Yield/R (g)	SSB/R (g)
Virgin	0.000	0.00	133.49
$F_{0.1}$	0.328	15.80	53.96
F_{max}	0.993	17.80	25.03

4.2.9.8 Data quality

Since 2009 commercial data by age and length have not been expanded to the whole landings, and thus the total number was adjusted using SOP correction. Since standardized survey data were not available, MEDITS abundance indexes and length frequency distributions (LFDs) were computed directly by the researchers of the GSA 9. Although, MEDITS LFDs were splitted in age to obtain the tuning data file to apply XSA method, the blue whiting benthopelagic habits characterized by large aggregations might make the bottom trawl MEDITS survey unsuitable for deriving tuning indexes for blue whiting. Thus, it is important to carry out an echosurvey targeting pelagic and benthopelagic species such as blue whiting to obtain accurate fishery independent estimations of the abundance at sea of those species. Finally, both in landings and discards data, some differences in age (especially in age 2, Fig. 4.2.9.8.1) and length structures, were detected. These differences may have determined an overestimation in fishing mortality in the previous assessments.

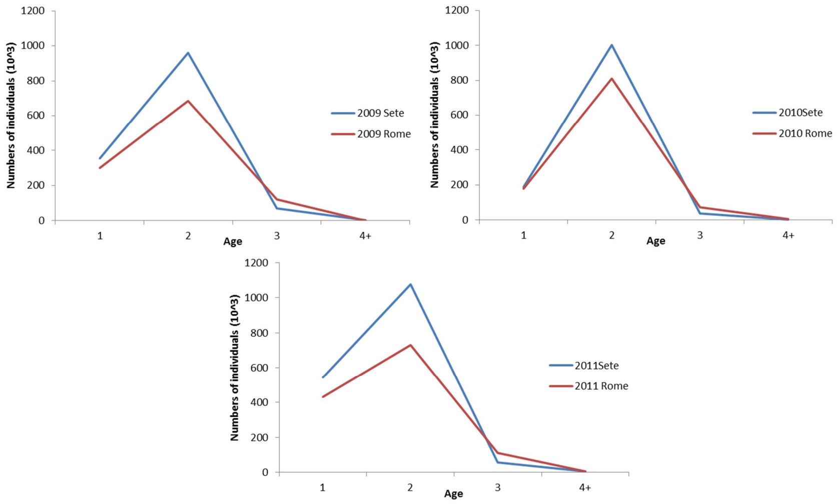


Fig. 4.2.9.8.1. Blue whiting in GSA 9. Comparison among age structures for years 2009-2011 available in EWG 12-10 held in Sete and EWG 14-09 in Rome.

4.2.9.9 Scientific advice

SSB and recruitment were rather stable during the analysed time period and F is only slightly larger than F_{MSY}.

4.2.9.10 Short term considerations

4.2.9.10.1 State of the stock size

An XSA (Extended Survivor analysis) assessment was computed using DCF data. According to the XSA outputs, the SSB was quite stable, varying around a mean value of about 260 (t) in the period 2009-2013. Nevertheless, due to the absence of proposed or agreed biomass management reference points, the EWG 14-09 is unable to fully evaluate the state of the spawning stock in respect to these.

4.2.9.10.2 State of recruitment

According to the XSA analyses, the recruitment of blue whiting in GSA 9 fluctuated around a mean value of about 7613 (thousands) without a clear pattern over the analysed period.

4.2.9.10.3 State of exploitation

EWG 14-09 proposed $F_{0.1}$ = 0.32 as proxy of F_{MSY} exploitation reference point. The current F (0.38) is larger than F_{MSY} (0.32), which indicates that blue whiting in GSA 9 is exploited unsustainably.

4.2.9.11 Management recommendations

EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings.

This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

4.2.10 STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 9

4.2.10.1 Stock Identification

Due to a lack of information about the structure of Norway lobster (*Nephrops norwegicus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries. Adults tend to be territorial, with limited migration. However, transferal of larvae between areas may occur.

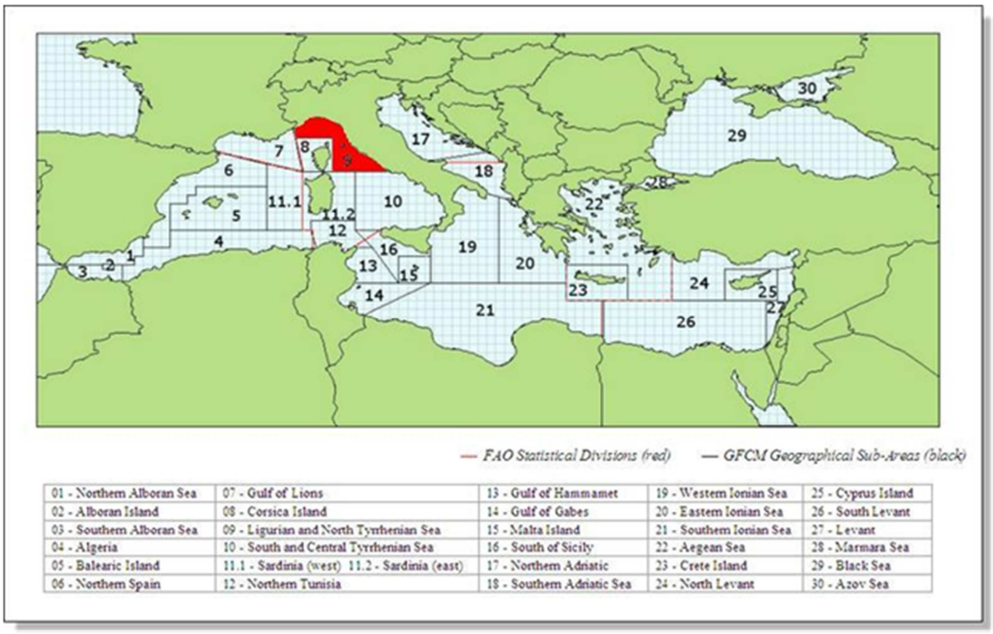


Fig. 4.2.10.1.1. Geographical location of GSA 9.

Norway lobster is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence from burrows of individuals may vary depending on biological features or environmental factors (moult or reproduction cycles, light intensity, etc). The species lives on muddy substrates at depths between 150 and 800 m, but in the area is more commonly found between 250 and 800 m depth (Biagi *et al.*, 2002; Colloca *et al.*, 2003). Recruits peak in abundance between 400 and 500 m depth over the upper slope and appear to move slightly deeper when they reach 30 mm carapace length (Fig. 4.2.10.1.2).

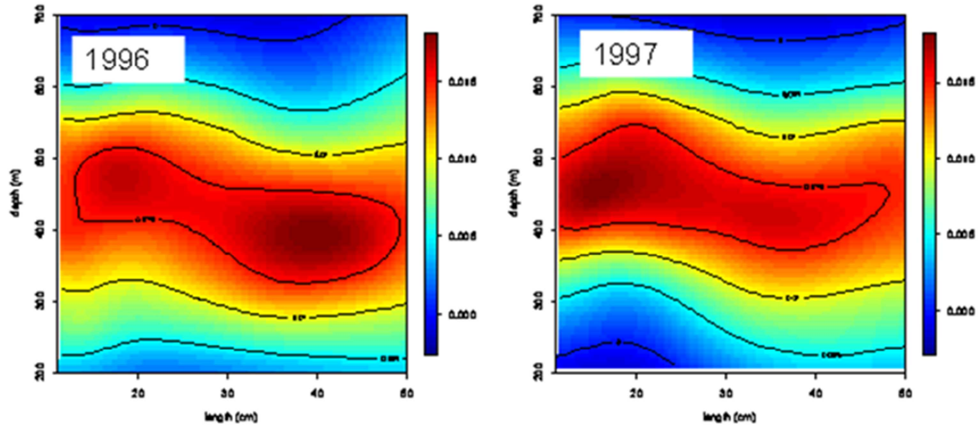


Fig. 4.2.10.1.2. Norway lobster in the GSA 9. Size-depth distribution of in 1996 and 1997 (GRUND survey).

4.2.10.2 Growth

The species shows a noticeable sexual dimorphism, with males that reach bigger sizes than females. Maximum observed size in the GSA 09 was 72 mm Carapace Length (CL) for males and 57 mm CL for females.

Growth parameters defined in the area were:

L_∞ =72.1 (males)	56 (females)	74.1 (sex combined)
K = 0.169 (males)	0.214 (females)	0.170 (sex combined)

Length-weight relationship for both sexes: a = 0.001, b = 3.080

4.2.10.3 Maturity

Males reach maturity at 40 mm CL and females at 30.3 mm CL. Sex ratio is about 1:1 until 26 mm CL; in favour of females from 26 to 35 mm CL; in favour of males from 38 mm CL (De Ranieri *et al.*, 1996). Reproduction peak is between spring and summer, and females with external eggs are observed in autumn-winter.

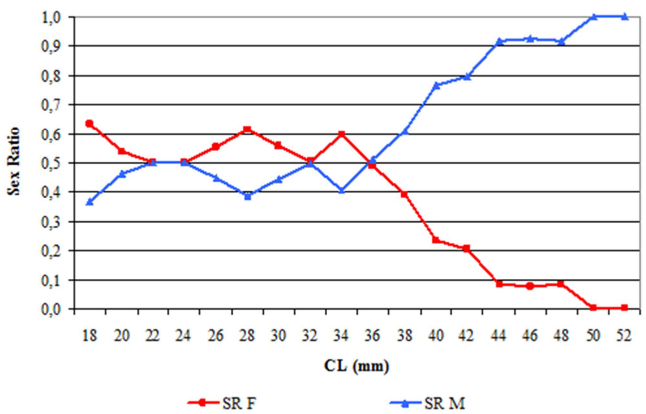


Fig. 4.2.10.3.1. Norway lobster in GSA 09. Sex ratio by length.

4.2.10.4 Fisheries

4.2.10.4.1 General description of Fisheries

Norway lobster is one of the most important commercial species in the GSA 9 for total annual landing and economic value.

According to the EU Fleet Register, the trawlers (OTB as main gear) of GSA 9 in 2013 accounted for 332 units (Tab. 4.2.10.4.1.1). From those vessels, only a fraction (80-100) targets Norway lobster.

The main trawl fleets of GSA 9 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium).

Tab. 4.2.10.4.1.1. Technical characteristics of the trawl fleet of GSA 9 (year 2013, EU Fleet Register).

Number of vessels	332
Total GT	11,460
Total kW	67,891
Mean GT	34.5
Mean kW	204.5
Mean length	16.9

The majority of bottom trawlers of GSA 9 operates daily fishing trips with only some vessels able to stay out of the port for two-three days especially in summer.

Norway lobster fishing grounds include soft bottoms of upper slope, mainly between 300 and 500 m depth. Fishing pressure shows some geographical differences inside the GSA 9 according to the consistency of the fleets, the availability of the resources and the morphology of the continental shelf and upper slope.

Catch of vessels targeting Norway lobster is composed of a mix of both commercial (*Merluccius merluccius*, *Micromesistius poutassou, Phycis blennoides, Lepidorhombus bosci, Galeus melastomus, Parapenaeus longirostris, Eledone cirrhosa, Todaropsis eblane, Trachurus* spp.) and non-commercial species.

4.2.10.4.2 Management regulations applicable in 2014

- Minimum conservation size: 20 mm CL or 7 cm TL.
- Fishing closure for trawling: 30-45 days in late summer – beginning of autumn (not every year have been enforced).
- Cod end mesh size of trawl nets: 40 mm square meshes or, under certain conditions, 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coast with the exception of some areas of the Ligurian Sea that have

benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.

- Two small No Take Zones ("Zone di Tutela Biologica", ZTB) are present inside the GSA 9; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTBs. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

4.2.10.4.3 Catches

4.2.10.4.4 Landings

Landings of Norway lobster in GSA 9 are almost exclusively provided by trawling (Tab. 4.2.10.4.4.1). Very low values have been detected also for gillnet and trammel net. In the last eight years the total landing varied between 148 (2013) and 260 (2007) tons (Fig. 4.2.10.4.4.1), showing an evident decreasing trend.

Tab. 4.2.10.4.4.1. Norway lobster in GSA 9. Landings (t) by fishing technique as officially reported through the 2014 DCF data call.

FT_LVL4	2006	2007	2008	2009	2010	2011	2012	2013
GNS	0.095	0.000	0.047	0.000	0.009	0.008	0.043	0.000
GTR	0.000	0.000	0.000	0.038	0.030	0.028	0.301	0.000
OTB	247.391	260.547	227.674	250.239	161.606	183.923	177.843	147.649
Total	247.486	260.547	227.721	250.277	161.645	183.958	178.187	147.649

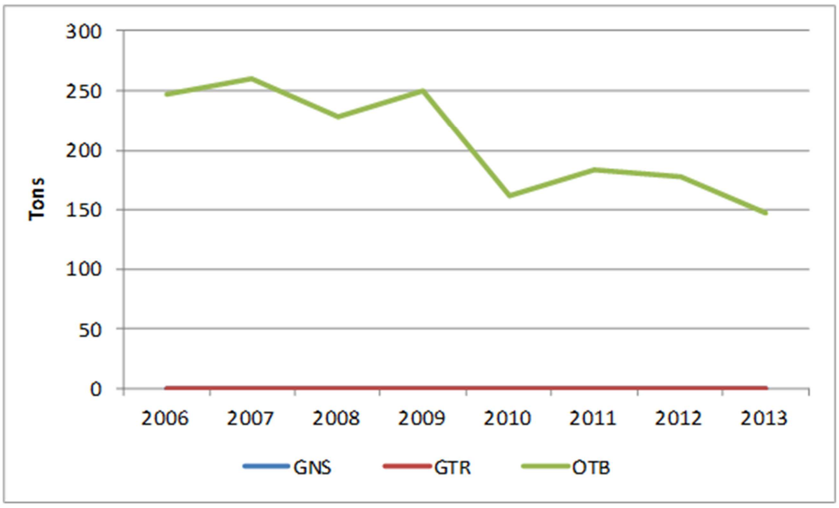


Fig. 4.2.10.4.4.1. Norway lobster in the GSA 9. Landings (t) from 2006 to 2013 (DCF official data).

Landings are mostly composed by specimens from 25 to 50 mm CL (Fig. 4.2.10.4.4.2-3) which correspond to individuals over 2+. Due to the different growth rates the species, the majority of the specimens greater than 40 mm CL are males.

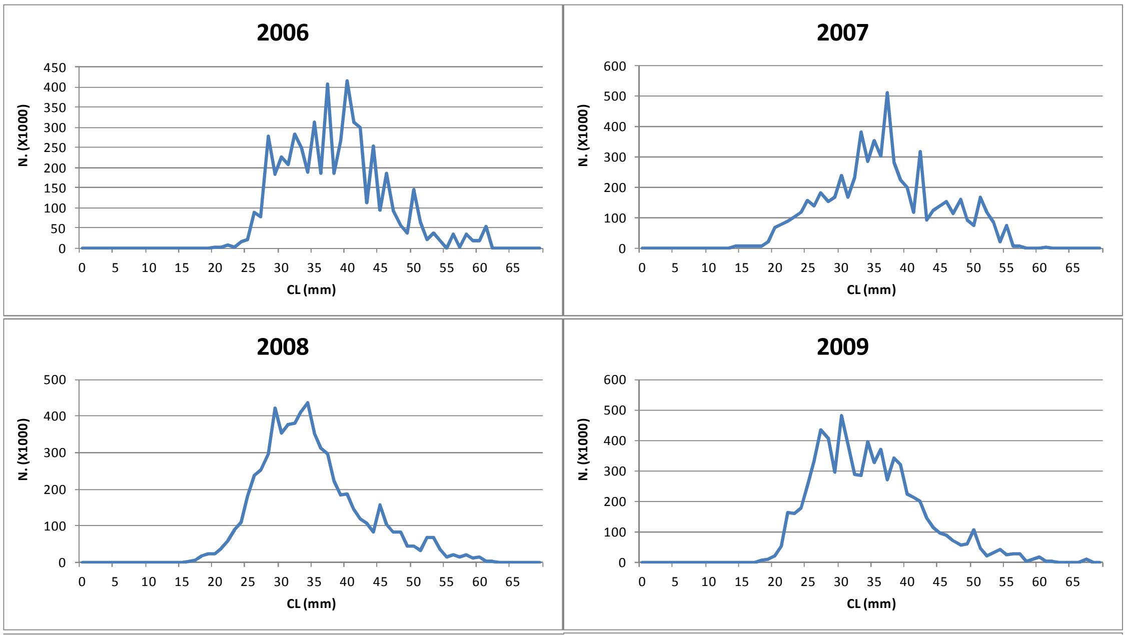


Fig. 4.2.10.4.4.2. Norway lobster in the GSA 9. Size structure of the landings in 2006-2013 caught by otter trawling (DCF official data).

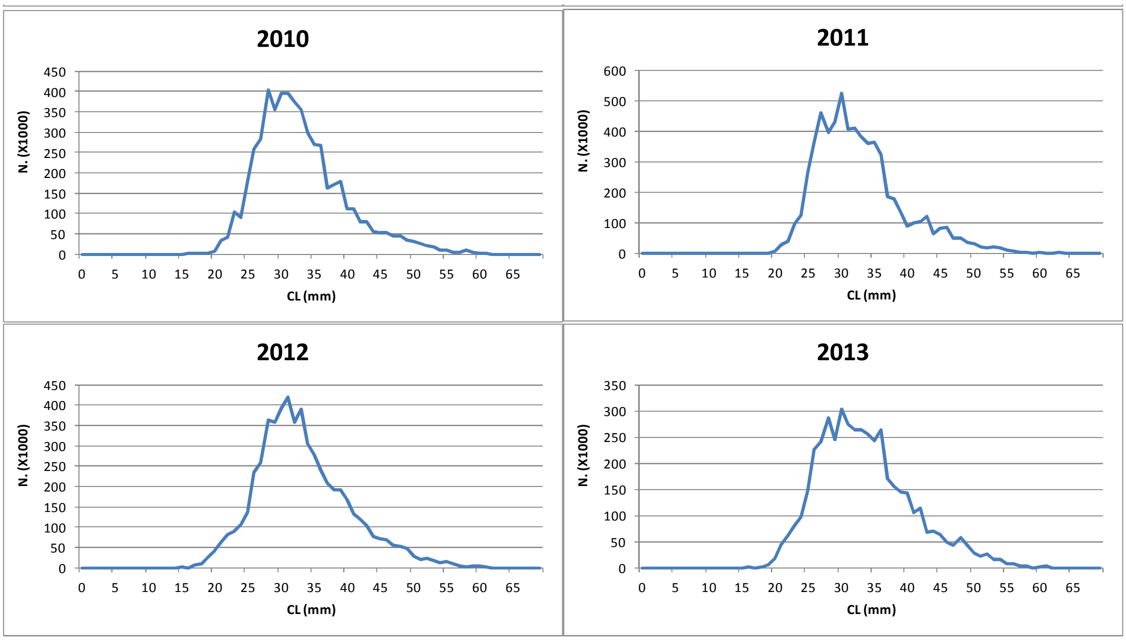


Fig. 4.2.10.4.4.3. Norway lobster in the GSA 9. Size structure of the landings in 2006-2013 caught by otter trawling (DCF official data).

Several EU and national projects carried out in GSA 9 highlighted that discard of Norway lobster in GSA 9 is negligible. At the same time, the presence of specimens under the MLS (20 mm CL) in the landings is very scarce. The same picture was obtained during the monitoring of discard performed in the 2006 DCR. According to the 2014 DCF data call, discard of Norway lobster is around 1 ton per year, with the only exception of 2009 when 9 tons have been estimated.

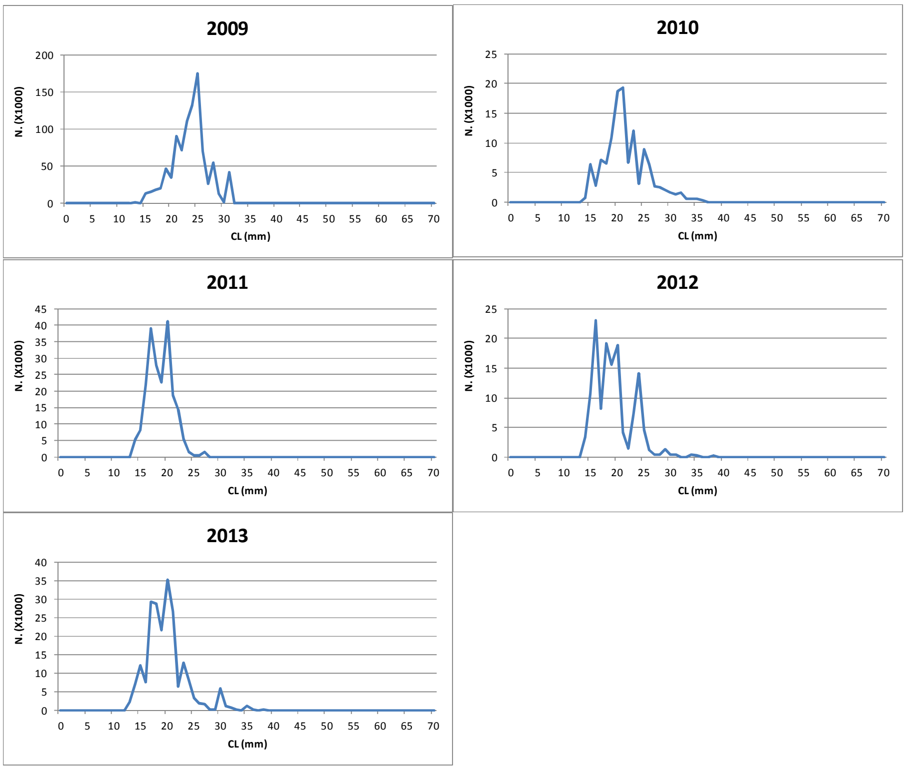


Fig. 4.2.10.4.4.4. Norway lobster in the GSA 9. Size structure of the discards of in 2006-2013 caught by otter trawling (DCF official data).

Tab. 4.2.10.4.4.2. Norway lobster in GSA 9. Discards (t) of by fishing technique as officially reported through the 2014 DCF data call.

FT_LVL4	2006	2007	2008	2009	2010	2011	2012	2013
OTB	0.000	N.A.	N.A.	9.240	1.015	1.037	0.790	1.330

4.2.10.4.5 Fishing Effort

The fishing capacity of the GSA 9 has shown in these last 10 years a progressive decrease (Fig. 4.2.10.4.5.1). From 1996 to 2006 the number of bottom trawlers of GSA 9 decreased of about 30%.

Fishing effort, expressed as kw*days at sea, performed by all the GSA 9 trawlers varied from about 14,800,000 in 2004 to 10,000,000 in 2012 (Tab. 4.2.10.4.5.1). Anyway, there is no information on the specific effort directed to *N. norvegicus* in GSA 9.

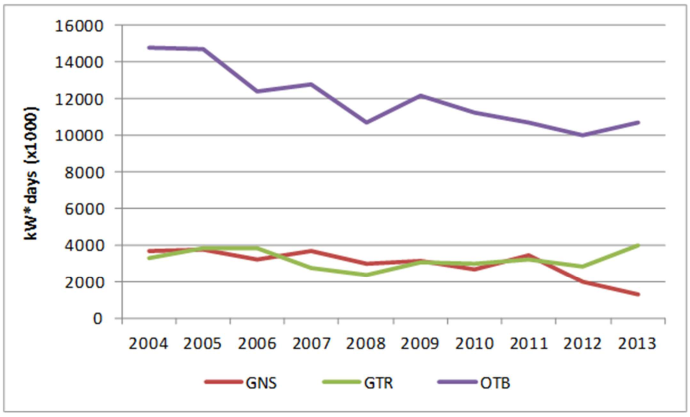


Fig. 4.2.10.4.5.1. Effort trends (kW*days) in 2004-2013 by fleets fishing for Norway lobster in GSA 9.

Tab. 4.2.10.4.5.1. Effort trends (kW*days*1000) in GSA 9 as reported in the official 2014 DCF Data Call.

FT_LVL4	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GNS	3735	3782	3246	3684	3004	3186	2713	3437	1984	1345
GTR	3279	3815	3862	2761	2415	3047	2981	3232	2855	3994
OTB	14820	14701	12405	12782	10694	12176	11228	10696	9998	10725
Total	21835	22297	19513	19228	16113	18410	16922	17365	14836	16064

4.2.10.5 Scientific surveys

4.2.10.5.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 9 the following number of hauls was reported per depth stratum (Tab. 4.2.10.5.1.1).

Tab. 4.2.10.5.1.1 MEDITS survey. Number of hauls per year and depth stratum in GSA 9, 1994-2013.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GSA09 010-050	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16
GSA09 050-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17
GSA09 100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30
GSA09 200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35
GSA09 500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma\ (Yi*Ai)\ /\ A$$
$$V(Yst) = \Sigma\ (Ai^2 * si^2 / ni)\ /\ A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

4.2.10.5.2 Geographical distribution

Norway lobster is distributed in the whole GSA with the highest abundance in the south-eastern Ligurian Sea and northern Tyrrhenian Sea. This spatial pattern corresponds to the position of the persistent spawning areas of the species (Fig. 4.2.10.5.2.1).

Persistent nursery areas of Norway lobster have been identified only in the eastern Ligurian Sea (Fig. 4.2.10.5.2.2).

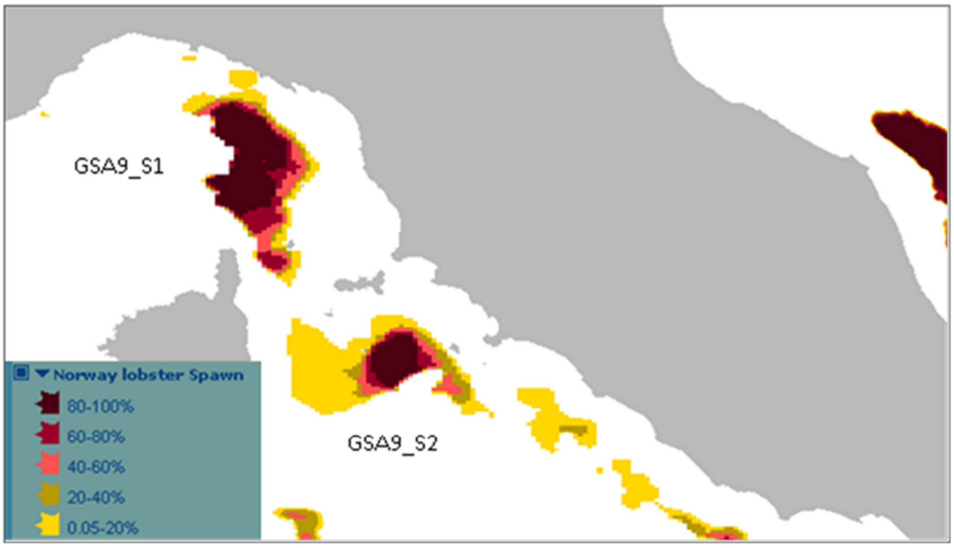


Fig. 4.2.10.5.2.1. Norway lobster in GSA 9. Position of persistent spawning areas.

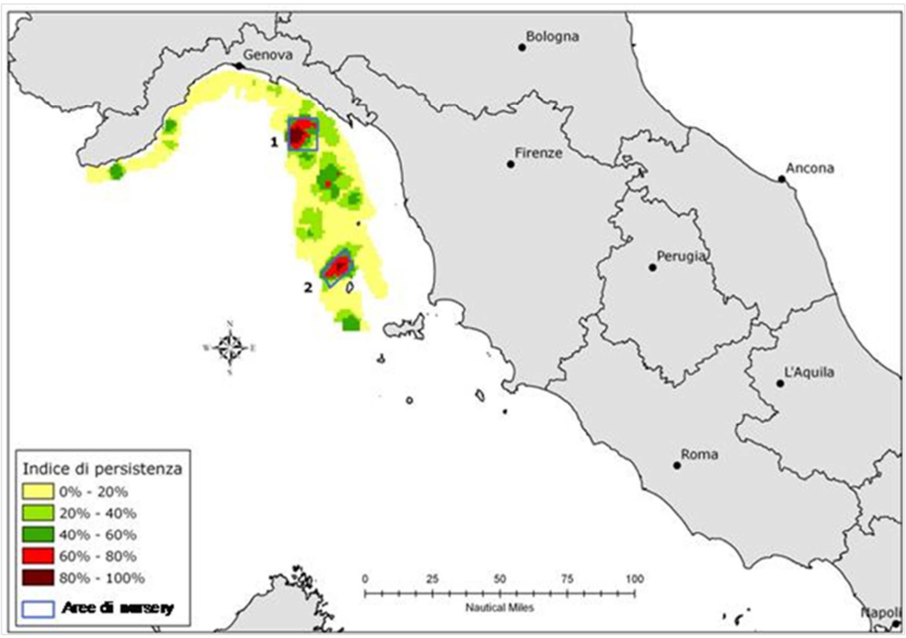


Fig. 4.2.10.5.2.2. Norway lobster in GSA 09. Position of persistent nursey areas.

4.2.10.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of Norway lobster in GSA 9 was derived from the international survey MEDITS. Fig. 4.2.10.5.3.1 displays the re-estimated trend in Norway lobster abundance and biomass in GSA 9 based on the DCR Data Call. The trend shows fluctuations withouth any particular pattern. Since 2005 a positive trend is observed, reaching in 2009 the maximum value since 1994. In 2013 the lowest indices of the data series have been found.

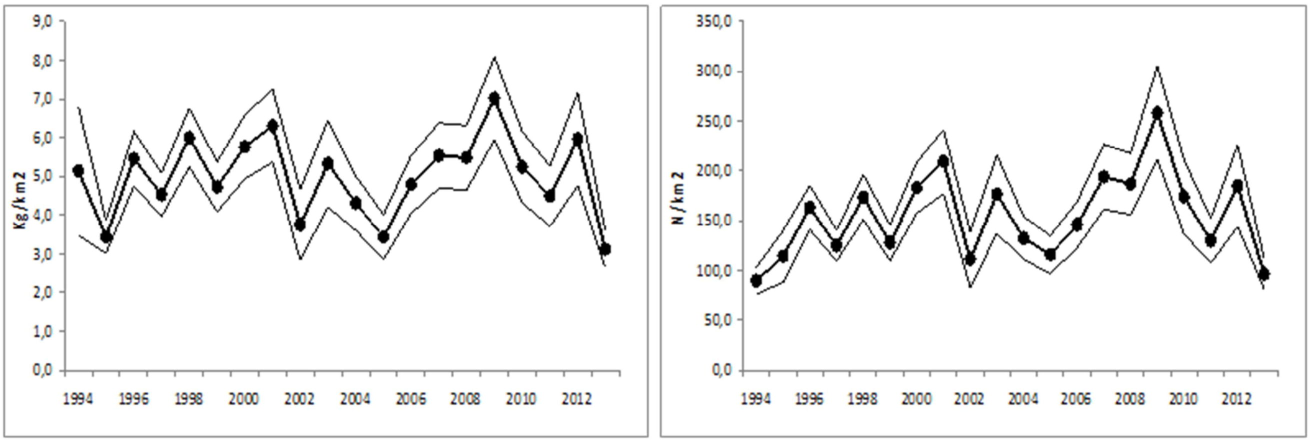


Fig. 4.2.10.5.3.1. Norway lobster in GSA 9. Abundance and biomass indices.

4.2.10.5.4 Trends in abundance by length or age

The following Figs. 4.2.10.5.4.1-3 display the stratified abundance indices by size of Norway lobster in GSA 9 in 1994-2013.

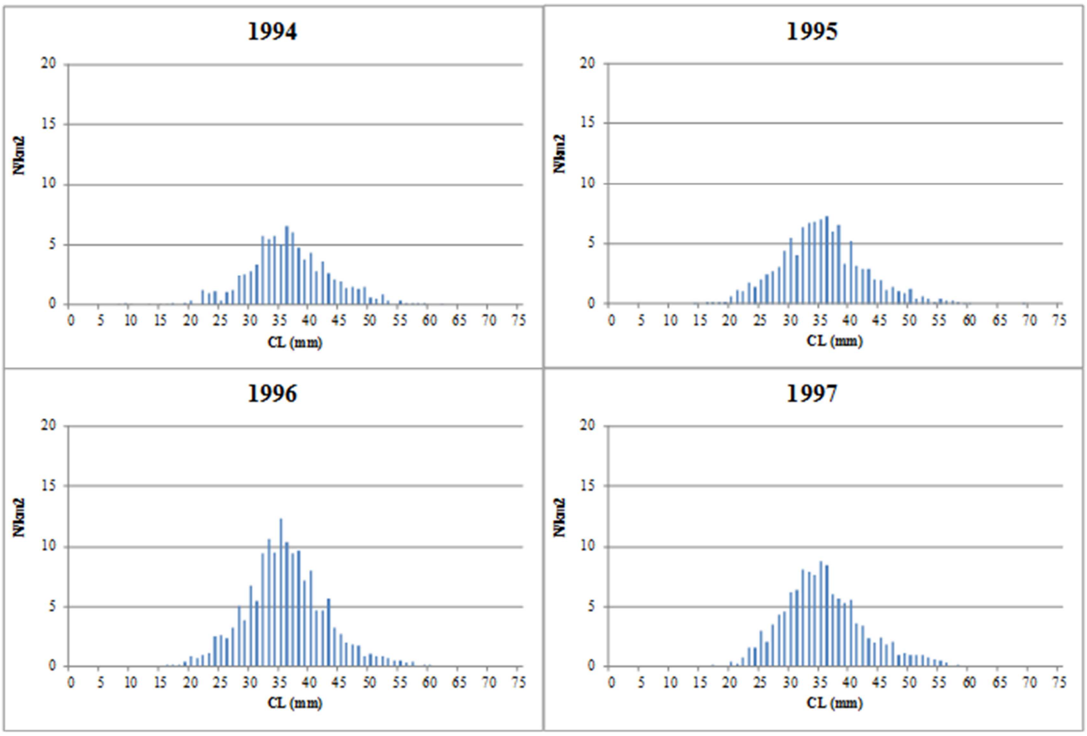


Fig. 4.2.10.5.4.1. Norway lobster in GSA 9. Stratified abundance indices by size, 1994-1997.

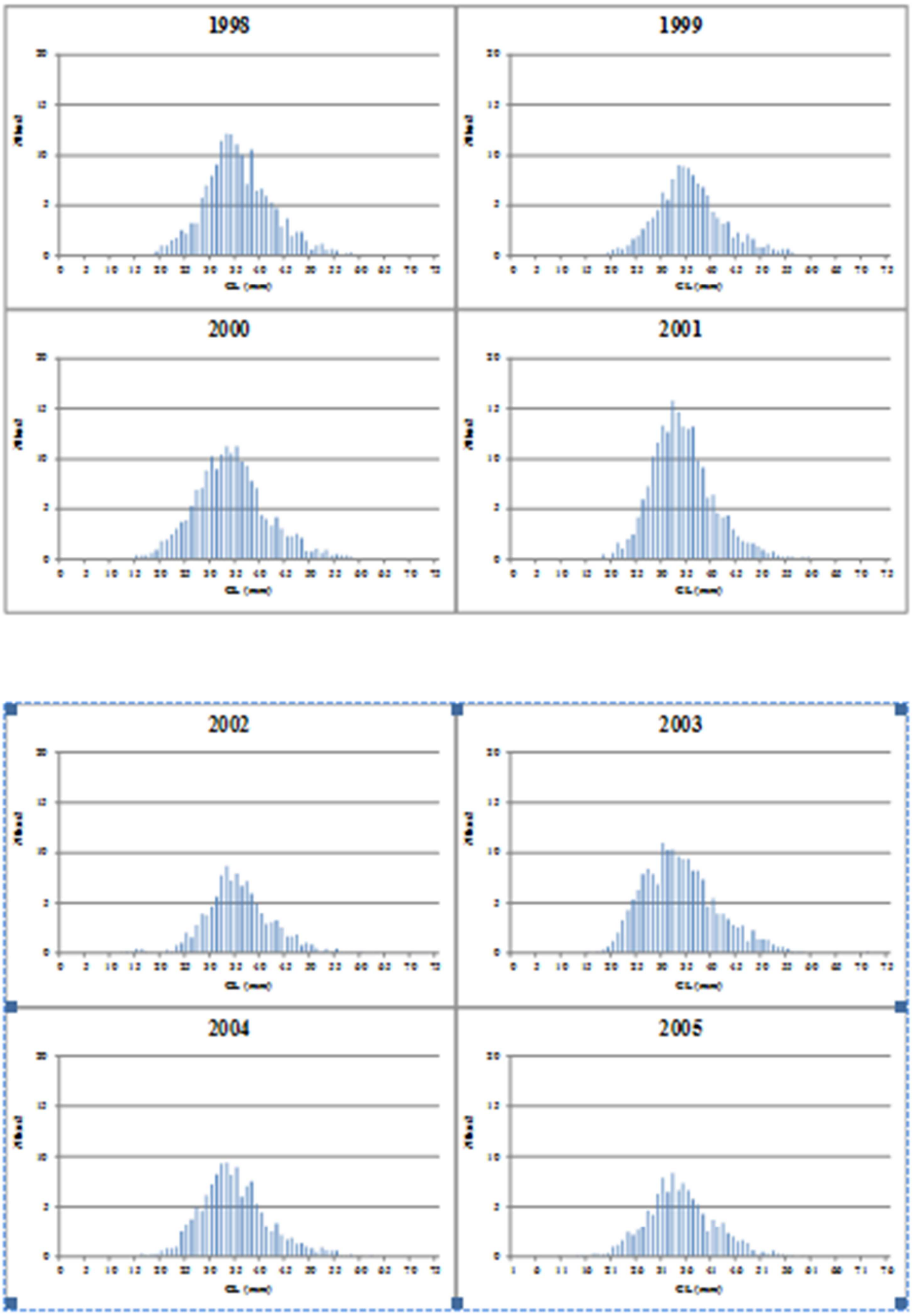


Fig. 4.2.10.5.4.2. Norway lobster in GSA 9. Stratified abundance indices by size, 1998-2005.

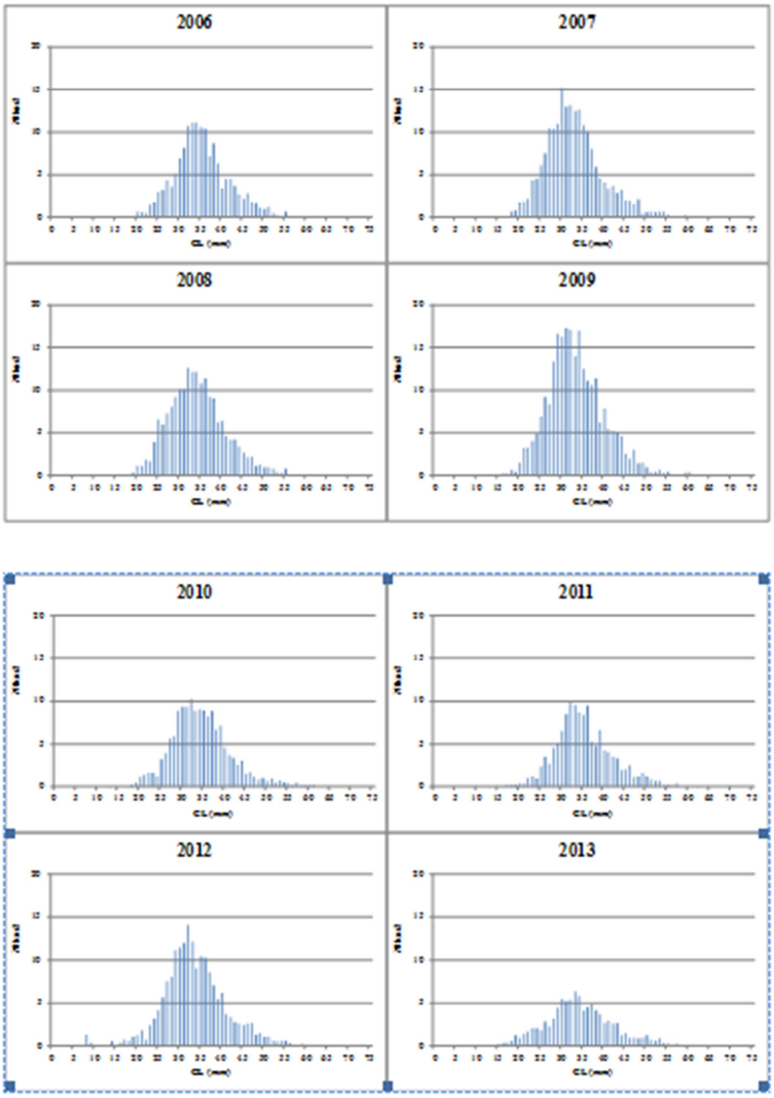


Fig. 4.2.10.5.4.3. Norway lobster in GSA 9 Stratified abundance indices by size, 2006-2013.

The boxplot of the MEDITS length frequencies distributions (LFDs) is shown in Fig. 4.2.10.5.4.4. The demographic structure of the Norway lobster stock in GSA 9 shows a high stability along the investigated period.

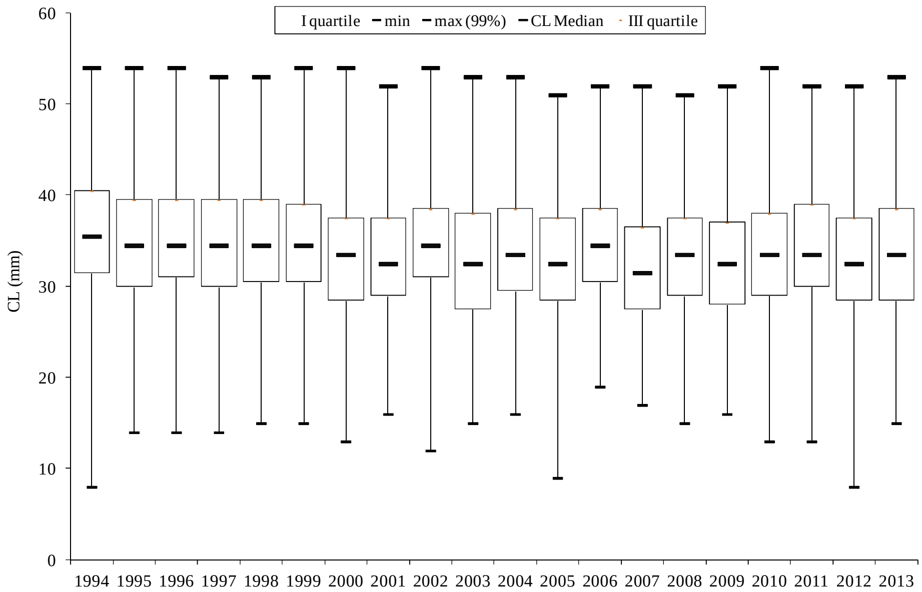


Fig. 4.2.10.5.4.4. Norway lobster in GSA 9 MEDITS abundance indices of age groups 2+ (data pooled).

4.2.10.5.5 Trends in growth

No specific analyses were conducted during STECF EWG 14-09.

4.2.10.5.6 Trends in maturity

No specific analyses were conducted during STECF EWG 14-09.

4.2.10.6 Assessment of historic stock parameters

Due to its importance as demersal resource, Norway lobster has been object of several assessments in the GSA 09 (Ardizzone *et al*., 1998; Abella & Righini, 1995; 1998; Abella *et al*., 1999; 2002; 2007; Biagi *et al*., 1990a; 1990b; 1990c; De Ranieri 1999; Mori *et al*., 1993; 1998; Sartor *et al*., 2003, Sbrana *et al*., 2003). These results are published and have been regularly updated in the GFCM SAC. The assessments performed with different approaches in different periods or in different subareas of the GSA 9 showed divergent results as *Nephrops* grounds within GSA 9 are not exploited with the same rate. It is likely that the current status (abundance and demographic structure) may depend mainly on the fishing pressure exerted in the different sub areas of the GSA9. This fact does not exclude the possibility of drifting of eggs and larvae from one ground to others contributing to recruitments in grounds different from the parental ones.

The Norway lobster in the GSA 9 seems to be fully or in some cases underexploited, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$ and SSB_{curr}/SSB_0). The production models based on Z provided total mortality estimates for the whole GSA 9 greater than the mortality corresponding to the maximum biological production (Z_{MBP}).

A clear growth overfishing is not observed, considering that the smaller individuals, 0+ and 1+ age classes, even though present in the fishing grounds, show a limited vulnerability to the fishing gear. The values of the SSB/SSB_0 ratio are between 0.33 and 0.45.

More recently, data coming from MEDITS (1994-2010) trawl survey were used to estimate relative SSB and F using SURBA (STECF EWG 11-12). DCF data (size distribution of trawl landings 2006-2010) were used to estimate F at age, absolute abundance at age with VIT (LCA analysis). The estimated value of $F_{0.1}$ =0.21 has been proposed as limit management reference point for sustainable exploitation consistent with high long term yield (FMSY proxy). The values of F_{bar} btained on commercial data with LCA (VIT) and using SURBA indicate that the stock is subject to overfishing.

4.2.10.6.1 Method 1: XSA

4.2.10.6.2 Justification

Assessment was performed using a VPA (XSA) applied to an age structured data series of eight years (from 2006 to 2013). Data coming from Medits survey have been used for tuning.

4.2.10.6.3 Input parameters

Data coming from DCF provided at STECF EWG 14-09 contained, for GSA 9, information on landings and the respective size/age structure for 2006-2013 (Fig. 4.2.10.6.3.1). Plus group was set at age 7. The number of individuals by age was SOP corrected [SOP = Landings / Σa (total catch numbers at age a x catch weight-at-age a)]. However, the correction factor resulted very low as age distributions cover the main *metiers* targeting Norway lobster (Tab. 4.2.10.6.3.1).

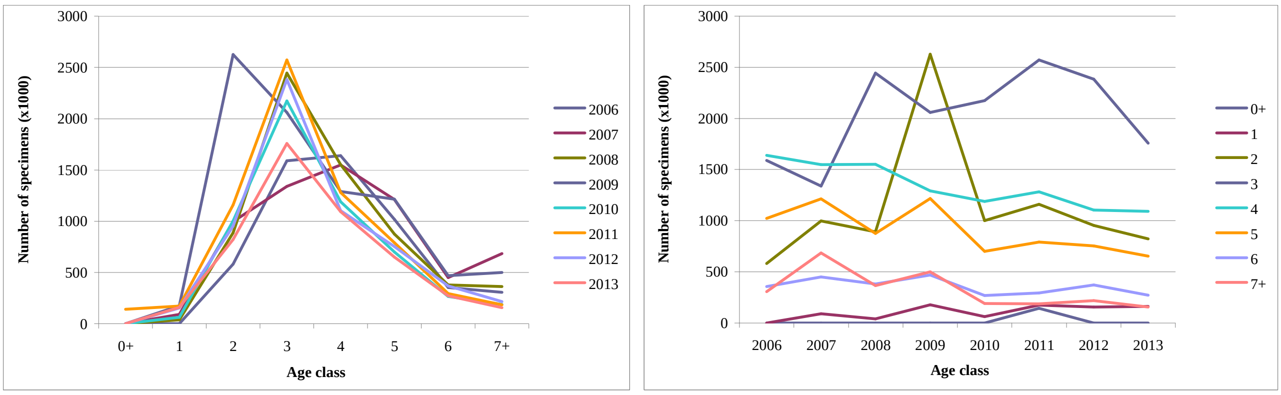


Fig. 4.2.10.6.3.1. Norway lobster in GSA 9. Catch in numbers by age and year used in the XSA.

Table 4.2.10.6.3.1. Norway lobster in GSA 9. Catch in numbers (10^3) by age and year used in XSA and SOP correction factor.

	0+	1	2	3	4	5	6	7+	SOP
2006	0	1	583	1590	1639	1020	354	306	1,000
2007	0	91	997	1339	1548	1213	449	685	1,000
2008	0	39	890	2444	1551	875	379	365	1,003
2009	0	177	2627	2060	1292	1217	469	500	1,000
2010	0	62	1002	2172	1189	701	267	189	1,018
2011	142	173	1160	2571	1281	791	294	187	1,020
2012	0	156	954	2384	1103	753	370	217	1,017
2013	0	161	822	1759	1092	653	271	156	1,015

Mean weight at age use for the XSA analyses are reported in Tab. 4.2.10.6.3.2. Survey standardized length frequency distributions were splitted in age classes (up to the age class 7+) by LFDA. Analysis was performed by sex combined (Tab. 4.2.10.6.3.3). Given that the landings were composed mainly of individuals between 2 and 5 years, these ages were selected as the F_{bar}.

Table 4.2.10.6.3.2. Norway lobster in GSA 9. Mean weigths at age used in the XSA (both in catch and stock).

	0+	1	2	3	4	5	6	7+
2006	0.000	0.006	0.015	0.025	0.042	0.059	0.082	0.129
2007	0.000	0.005	0.012	0.024	0.035	0.051	0.072	0.099
2008	0.000	0.005	0.012	0.021	0.034	0.051	0.071	0.112
2009	0.000	0.005	0.012	0.022	0.035	0.046	0.064	0.102
2010	0.000	0.004	0.012	0.020	0.032	0.046	0.068	0.099
2011	0.020	0.004	0.012	0.020	0.031	0.047	0.069	0.098
2012	0.000	0.007	0.012	0.021	0.033	0.047	0.066	0.097
2013	0.000	0.004	0.011	0.020	0.033	0.048	0.069	0.106

Table 4.2.10.6.3.3. Indices (n/km^2) from MEDITS survey used in XSA.

	0+	1	2	3	4	5	6	7+
2006	0.00	0.97	21.18	66.01	36.81	14.79	5.55	2.75
2007	0.00	3.95	52.92	86.91	32.36	13.05	4.53	3.20
2008	0.00	2.07	41.22	77.58	42.54	15.61	5.30	3.13
2009	0.00	4.09	61.52	106.51	48.82	18.32	6.03	3.16
2010	0.00	2.41	29.21	63.78	36.35	11.54	3.97	4.03
2011	0.00	1.55	19.77	58.37	31.11	12.60	5.27	3.07
2012	1.69	5.07	39.12	79.12	37.24	13.03	6.09	3.48
2013	0.00	4.40	19.90	37.90	22.16	8.52	4.12	3.00

Biological parameters are listed in Tabs. 4.2.10.6.3.4-6. A natural mortality vector computed using ProdBiom (Abella, 1998) was used.

Table 4.2.10.6.3.4. Norway lobster in GSA 9. Proportion of matures at age used in XSA.

0+	1	2	3	4	5	6	7+
0.01	0.10	0.25	0.50	0.80	1.00	1.00	1.00

Table 4.2.10.6.3.5. Norway lobster in GSA 9. Natural mortality at age used in XSA.

0+	1	2	3	4	5	6	7+
1.28	0.61	0.48	0.42	0.39	0.37	0.36	0.35

Table 4.2.10.6.3.6. Norway lobster in GSA 9. Growth and length weight relationships parameters used in PRODBIOM.

Linf	K	to	a	b
74.0	0.17	0.0	0.001	3.08

4.2.10.6.4 Results

A sensitivity analysis testing different shrinkage weights was performed before running the final XSA (Sh0.5, 1.0, 1.5, 2.0, 2.5 and 3.0) (Fig. 4.2.10.6.4.1). The analysis of the residuals show very similar patterns and an intermediate option (Sh1.5) was selected (Fig. 4.2.10.6.3.1). Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 1 to - 1, and did not show any trend with time (Tab. 4.2.10.6.4.1).

Fig. 4.2.10.6.4.1. Norway lobster in GSA 9. Estimates of F, recruitment and SSB with different shrinkage settings.

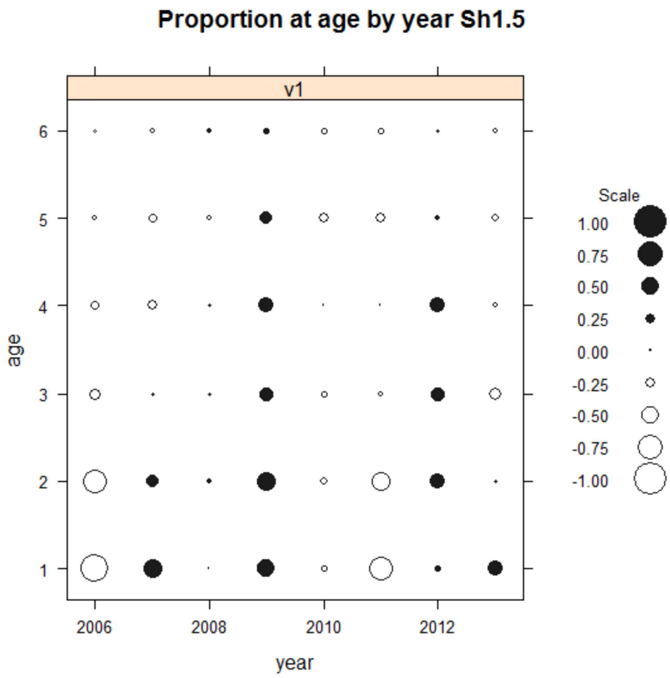


Fig. 4.2.10.6.4.2. Norway lobster in GSA 9. Bubble plot of residuals of model Sh1.5.

Table 4.2.10.6.4.1. Norway lobster in GSA 9. Log catchability residuals by age and year (Sh1.5).

Age	2006	2007	2008	2009	2010	2011	2012	2013
1	-0.733	0.494	-0.012	0.435	-0.092	-0.625	0.106	0.383
2	-0.611	0.295	0.066	0.473	-0.164	-0.49	0.357	0.036
3	-0.253	0.029	0.027	0.326	-0.105	-0.059	0.316	-0.302
4	-0.18	-0.223	0.045	0.36	-0.012	-0.017	0.35	-0.077
5	-0.081	-0.191	-0.063	0.305	-0.217	-0.22	0.064	-0.138
6	-0.044	-0.065	0.064	0.116	-0.12	-0.097	0.039	-0.071

XSA main outputs (Fig. 4.2.10.6.4.3) showed an increase in fishing mortality in the last three years, from the minimum of 0.33 observed in 2010 to 0.43 in 2013. Recruits showed an evident decreasing trend from 2007 to 2011 and fluctuations in the last years. An important reduction is observed for SSB, passing from 729 tons in 2006 to 355 tons in 2013. Both SSB and XSA stock summary results are reported in Tab. 4.2.10.6.4.2.

Fig. 4.2.10.6.4.3. Norway lobster in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Table 4.2.10.6.4.2. Norway lobster in GSA 9. Yield, Recruitmen and SSB estimates by XSA 2006-2013 (Sh1.5).

	age	2006	2007	2008	2009	2010	2011	2012	2013
Yield (tons)	all	246.1	260.78	227.38	259.99	162.86	181.81	179.9	147.52
Recruitment (x1000)	0+	113121	121701	102490	96781	82536	59147	90520	71367
SSB (tons)	all	729.26	671.55	593.97	581.51	460.39	463.86	429.64	355.27

Table 4.2.10.6.4.3. Norway lobster in GSA 9. Fishing mortality by age and year estimated by XSA (Sh1.5).

Age	2006	2007	2008	2009	2010	2011	2012	2013
0+	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00
1	0,00	0,00	0,00	0,01	0,00	0,01	0,01	0,01
2	0,05	0,08	0,07	0,20	0,09	0,11	0,10	0,13
3	0,21	0,18	0,36	0,30	0,34	0,45	0,45	0,38
4	0,41	0,42	0,42	0,42	0,36	0,44	0,46	0,50
5	0,67	0,80	0,57	0,91	0,53	0,54	0,65	0,70
6	0,65	0,94	0,79	0,89	0,64	0,55	0,67	0,65
7+	0,65	0,94	0,79	0,89	0,64	0,55	0,67	0,65
F_{2-5}	**0,33**	**0,37**	**0,35**	**0,46**	**0,33**	**0,39**	**0,42**	**0,43**

Table 4.2.10.6.4.4. Norway lobster in GSA 9. Stock in numbers (thousands) estimated by age and year.

year	0+	1	2	3	4	5	6	7+
2006	113121	32126	16946	10296	5924	2508	888	750
2007	121701	31452	17455	10027	5476	2662	884	1304
2008	102490	33838	17023	10017	5503	2434	830	777
2009	96781	28496	18357	9834	4600	2449	954	986
2010	82536	26909	15353	9293	4791	2052	680	470
2011	59147	22948	14575	8712	4345	2266	834	519
2012	90520	16370	12341	8106	3640	1887	908	520
2013	71367	25168	8780	6886	3394	1557	678	381

4.2.10.7 Long term prediction

4.2.10.7.1Justification

The yield per recruit (YpR) analysis was run using FLBRP routine.

4.2.10.7.2 Input parameters

Analysis was computed by sex combined using the same input parameters used for XSA.

4.2.10.7.3 Results

Yield per Recruit output curve is illustrated in Fig. 4.2.10.7.3.1, while in Tab. 4.2.10.7.3.1 and Fig. 4.2.10.7.3.2 are reported the main results of the analysis.

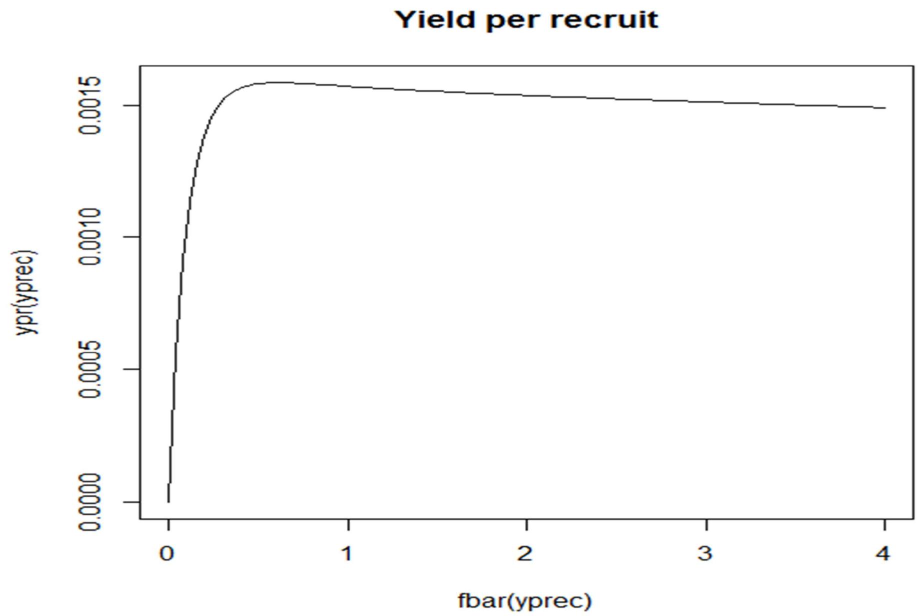


Fig. 4.2.10.7.3.1. Norway lobster in GSA 9. LCA outputs: Yield per recruit curve.

Tab. 4.2.10.7.3.1. Norway lobster in GSA 9. Comparison of estimated values of $F_{0.1}$, F_{max} and $F_{current}$ using XSA.

$F_{0.1}$	F_{max}	$F_{current\ (2-5)}$
0.214	0.609	0.426

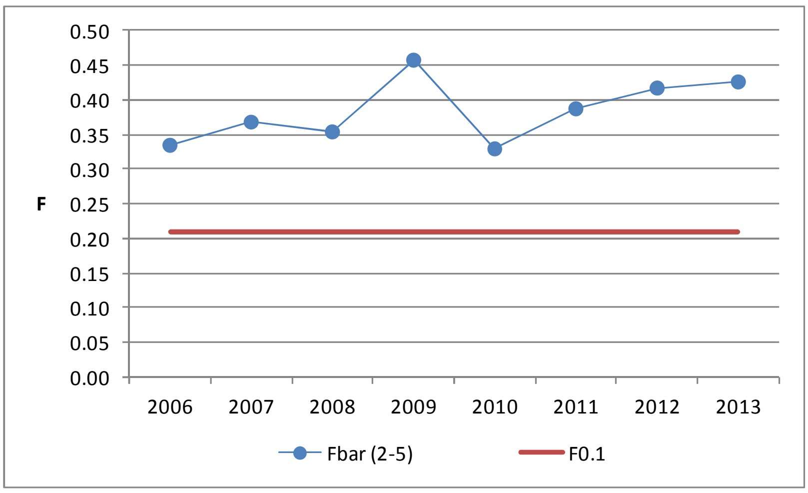


Figure 4.2.10.7.3.2. Norway lobster in GSA 9. Estimated values of F_{MSY} and $F_{current}$ using XSA.

4.2.10.8 Data quality

Since standardized survey data were not available, MEDITS abundance indexes and length frequency distributions (LFDs) were computed directly by the experts.

For age distributions of landing and discard DCF available at the STCF EWG 14-09, it is not possible to know which growth parameters have been applied. For length frequency distributions, data are available for sex combined. For species like Norway lobster where growth rates are different by sex, it would be useful to have separate data by sex.

4.2.10.9 Scientific advice

SSB and recruitment declined during the analysed period and F is twice F_{MSY}.

4.2.10.10 Short term considerations

4.2.10.10.1 State of the spawning stock size

According to the XSA results, SSB drastically decreased in the period analised, from about 730 tons in 2006 to 355 tons in 2013. Medits indices (abundance in (n/km^2 and biomass in kg/km^2), do not show a clear trend in the stock size for the period 1994-2013.

No precautionary biomass reference points have been proposed for the Norway lobster stock. Therefore, STECF EWG 14-09 is unable to fully evaluate the status of the stock spawning biomass with respect to the precautionary approach.

4.2.10.10.2 State of recruitment

Due to the biological and ecological characteristics of the species, juveniles are scarcely recruited by the trawl gear. The 0+ age group specimens are occasionally present both in the MEDITS and commercial catches.

4.2.10.10.3 State of exploitation

STECF EWG 14-09 proposes the estimated F_{MSY}=0.21 as limit management reference point for sustainable exploitation, consistent with high long term yield. The current F (0.43) is larger than F_{MSY} (0.21), which indicates that Norway lobster in GSA 6 is exploited unsustainably.

4.2.10.11 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed FMSY level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.11 STOCK ASSESSMENT OF ANCHOVY IN GSA 17-18

4.2.11.1 Stock Identification and biological features

Many studies have been carried out regarding the presence of a unique stock or the presence of different sub populations of anchovy in the Adriatic Sea (GSA 17 and GSA 18). This has several implications for the management, i.e. differences in the growth features between subpopulations imply the necessity of *ad hoc* strategies in the management. The hypothesis of two distinct populations claims the evidence of morphometric differences between northern and southern Adriatic anchovy, such as colour and length, and some variability in their genetic structure (Bembo *et al*., 1996). Nevertheless, many authors warn against the use of morphological data in studies on population structure (Tudela, 1999) and, a recent study from Magoulas *et al.* (2006), revealed the presence of two different clades in the Mediterranean, one of those is characterized by a high frequency in the Adriatic Sea (higher than 85%) with a low nucleotide diversity (around 1%). Therefore, in this year assessment, and according to the fact that a lot of vessels registered in GSA 18 fish in GSA 17, it was decided to merge the two GSAs and thus carry out an assessment for anchovy in GSA 17-18.

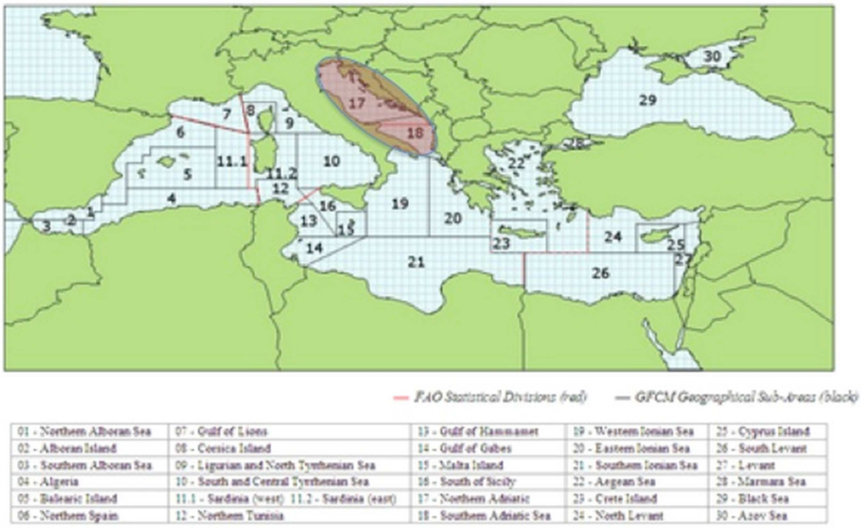


Figure 4.2.11.1.1. Geographical location of GSA 17-18.

4.2.11.2 Growth

The growth of anchovy in Adriatic Sea was assessed using the historical growth parameters (Sinovčić, 2000). Age-length and age-weight keys were produced using the otolith reading and actual length-weight parameters. The growth parameters used during the EWG 14-09 were:

Table 4.2.11.2.1. Anchovy in GSA17-18. Von Bertalanffy growth parameters.

Growth parameters	L_{inf}	**k**	t_0
Both sexes	19.4	0.57	-0.5

4.2.11.3 Maturity

Table 4.2.11.3.1. Anchovy in GSA 17-18. Proportion of mature specimens at age.

PERIOD	**Age**	**0**	**1**	**2**	**3**	**4**	**5+**
1975-2013	Prop. Matures	0.75	1.00	1.00	1.00	1.00	1.00

4.2.11.4 Natural mortality

Table 4.2.11.4.1. Anchovy in GSA 17-18. Natural mortality vector by age from Gislason et al. (2010) .

Period	**Age**	**0**	**1**	**2**	**3**	**4**	**5+**
1975-2013	M	2.36	1.10	0.81	0.69	0.64	0.61

4.2.11.5 Fisheries

4.2.11.5.1 General description of Fisheries

Anchovy is commercially very important in the Adriatic Sea: it is targeted by pelagic trawlers (Italy) and purse seiners (Italy, Croatia, Slovenia). The number of vessels targeting this species is around 400. Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17.

In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small.

4.2.11.5.2 Management regulations applicable in 2012

A multi–annual management plan for small pelagic fisheries in the Adriatic Sea has been established by the General Fisheries Commission for the Mediterranean (GFCM) in 2012. Besides, Italy has been enforcing for years a general regulation concerning the fishing gears and since 1988 a suspension (about one month) of fishing activity of pelagic trawlers in summer. A closure period is observed from 15th December to 15th January from the Croatian purse seiners. A closure period of 60 days (August and

September) and a closure period of 42 days were endorsed respectively in 2011-2012 and in 2013 by the Italian fleet.

4.2.11.5.3 Catches

4.2.11.5.4 Landings

Concerning GSA17, landings and catch at age data from 2004 were available through the DCF database for Italy and Slovenia. For Croatia, data from 2004 to 2012 were available through the Croatian experts, since Croatia is participating to the Data Collection Program starting in 2013: nevertheless, an error was detected from the experts itself in the DCF database for 2013, therefore they provided 2013 as well. Data before 2004 were provided for all the countries from the experts involved in the assessment.

To be consistent with the last year assessment, and given the fact that all the data before 2004 are available only as split-year data (assuming a birth data for anchovy at the first of June and therefore reconstructing all the biological data merging the months from June to December of one year, with the months from January to May of the following year), split-year has been applied to the entire dataset. This implies that all the data are shifted by one year (that's why the time series starts in 1976 and not in 1975) and that the last year of data (2013) is composed from the data June-December 2012 and the data January-May 2013.

Concerning GSA 18, the data were available through the DCF program starting in 2005; before that, the data were reconstructed as follows:

- 1975-1994: total landings for maritime compartment from the Italian National Institute of Statistic. The data were available until 1999, but in the last 5 years of data the landings showed an unreliable pattern, with high peaks. A similar behavior was evident also for the landings of another small pelagic, i.e. sardine, and it was therefore ascribed to some sampling issues (e.g. changing in the sampling methodology). For this reason the data from 1995 to 1999 were not included.
- 1995-2004: an average proportion of catches in GSA 18 over the catches in GSA 17 was estimated from the total landings available from the sampling program from 2006 to 2013 (i.e. GSA18/GSA17 = 34.4%). This ratio was used to derive an estimate of GSA 18 landings from GSA 17 for the period 1995-2004.
- 2005-2013: split-year assumption was applied to the GSA 18 numbers at age from DCF database using the split-year proportion from GSA 17 numbers at age of the last years of data (2005-2013).

The new data from 2013 as well as the landings for GSA 18 have been reconstructed using the split year assumption. To do that, an average monthly proportion of catch has been estimated from the more recent year (Jan-May=0.41; June-Dec=0.59) and applied to the total landings.

The reconstructed landings for GSA 18 together with the landings for GSA 17 are presented in figure 4.2.11.5.4.1. To account for the landings of Albania and Montenegro the FAO estimates (from the FAO database) were used: the average amount from 2004 to 2013 is about 20 t, therefore the values are included in the plot below together with GSA 18 estimates. A SOP correction has been applied to all the landings and numbers at age matrix (SOP correction on the average less than 10%).
Overall, observing the catch trend a collapse of anchovy catch in 1987 is evident. From 1988 the trend is increasing reaching the maximum of the entire time series in 2007 with 75,511 tons. From 2007 the catches are decreasing again.

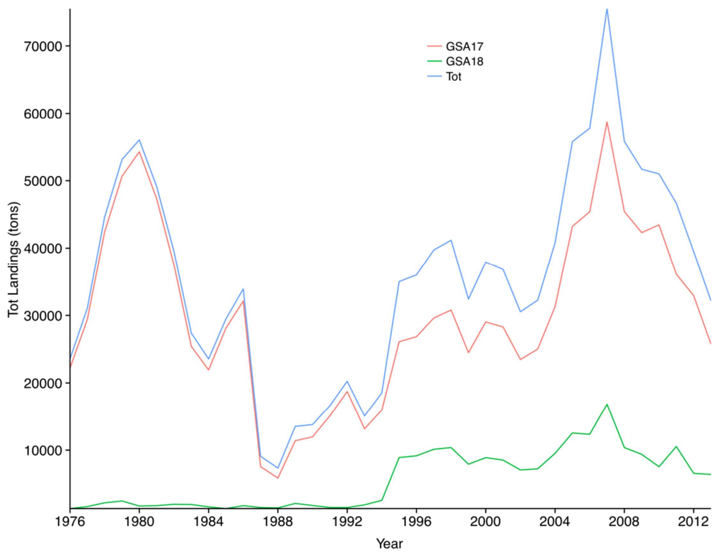


Figure 4.2.11.5.4.1. Anchovy in GSAs 17-18. Total reconstructed landings (in tons) by GSA from 1975 to 2013.

Once the split-year total landings have been estimated, a proportion of LDF (figure 4.2.11.5.4.2) from split-year GSA 18 in the period 2005-2013 has been used to split the total landings into numbers at length. Then, an average ALK from the port of San Benedetto (which is considered representative of the age distribution of GSA 18) has been applied to estimate the numbers at age (figure 4.2.11.5.4.3).

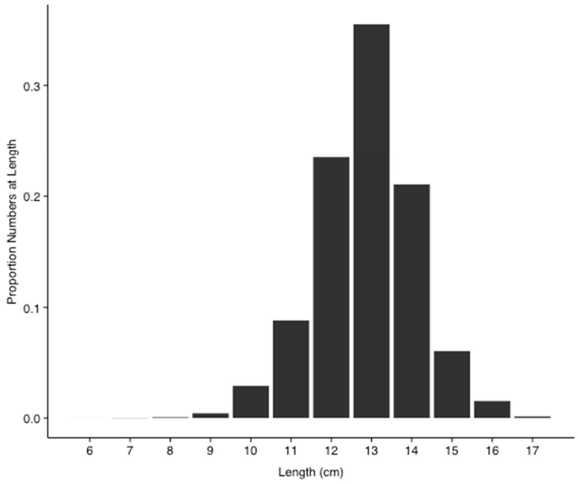


Figure 4.2.11.5.4.2. Length frequency distribution proportion from split-year GSA 18 catches 2005-2013 applied to the GSA 18 total landings from 1975 to 2004.

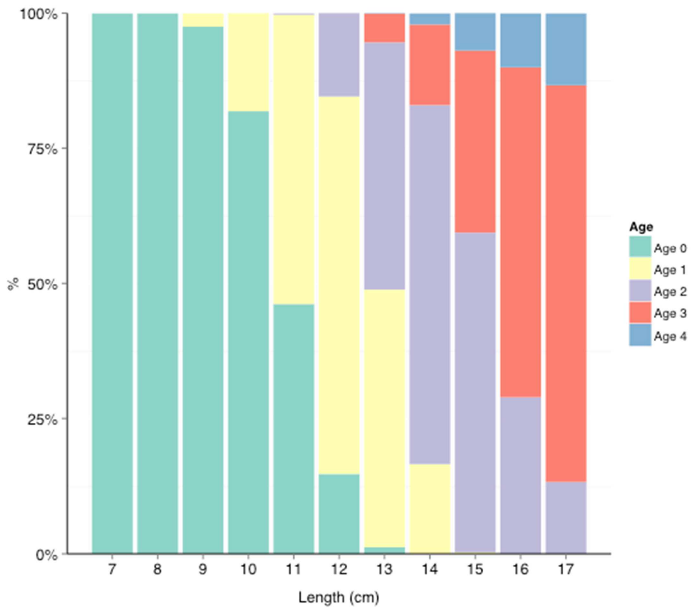


Figure 4.2.11.5.4.3. Age-Length Key from port of San Benedetto applied to the GSA 18 length frequency distribution to estimate the numbers at age of GSA 18.

The final catch at age for GSA 17-18 with the trend in cohorts is presented in figure 4.2.11.5.4.4. Each plot represents the number of fish of each age born in the same year. Age 1 can be identified as the first fully recruited age in most of the years.

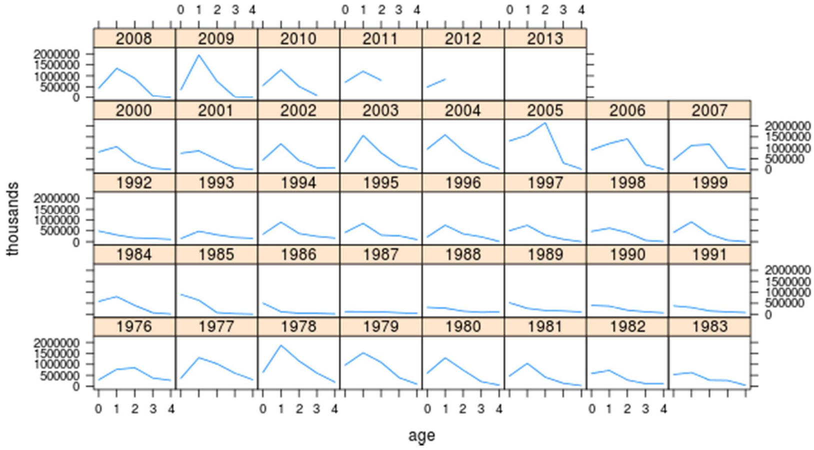


Figure 4.2.11.5.4.4. Anchovy in GSAs 17-18. Numbers at age (thousands) of the catch at age.

The following table shows the annual landings (t):

Table 4.2.11.5.4.1. . Anchovy in GSAs 17-18Total landings (tons) of anchovy by year.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1976	23581	**1986**	33910	**1996**	36007	**2006**	57748
1977	31060	**1987**	9082	**1997**	39733	**2007**	75511
1978	44638	**1988**	7347	**1998**	41174	**2008**	55813
1979	53115	**1989**	13513	**1999**	32410	**2009**	51697
1980	56023	**1990**	13788	**2000**	37927	**2010**	51000
1981	49143	**1991**	16619	**2001**	36810	**2011**	46646
1982	39523	**1992**	20252	**2002**	30534	**2012**	39498
1983	27382	**1993**	15076	**2003**	32259	**2013**	32150
1984	23552	**1994**	18533	**2004**	40806		
1985	29480	**1995**	35009	**2005**	55772		

The weight at age of the catches is shown in Figure 4.2.11.5.4.5. In 2012 the average weight for the oldest ages (2 to 4) had really low values, therefore an average between the previous and following years have been used.

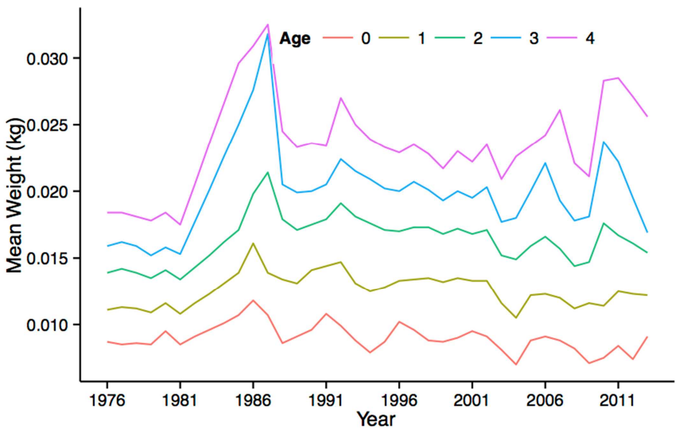


Figure 4.2.11.5.4.5. Anchovy in GSAs 17-18. Mean weight at age (kg) of the catch at age.

4.2.11.5.5 Discards

Discard was not included in the assessment.

4.2.11.5.6 Fishing Effort

The number of vessels from Italy, Croatia and Slovenia targeting this species is around 400. In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small.

4.2.11.6 Scientific surveys

4.2.11.6.1 Methods

MEDIAS

Echosurveys were carried out from 2004 to 2013 for the entire GSA 17 and 18. In the western part the acoustic survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area), and it is in the MEDIAS framework since 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON. The data from the two surveys have been used as two independent tuning indices in the form of numbers-at-age from 2004 to 2012. An inconsistency was found in the age matrix of the western acoustic survey: in 2012 a high numbers of age 4 is recorded, being the only age 4 of the time series. Besides, age 3 of previous year was equal to 0 individuals, therefore age 4 from 2012 was grouped with age 3.

The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2012).

Below the data available for each survey are summarized.

Western Echosurvey:

- GSA17
  - Length frequencies distribution available from 2004 onward (no LFD for Mid Adriatic in 2004, so the biomass at length in 2004 was assumed equal to the proportion of biomass at length in the 2005 Mid Adriatic survey);
  - ALK available from 2009;
  - Numbers at age for 2004 to 2008.
- GSA18
  - Length frequencies distribution available from 2009 onward.
  - Numbers at age from 2009 to 2013.

Eastern Echosurvey:

- Length frequencies distribution available from 2009.
- No ALKs available.
- Numbers at length from 2004 to 2008 were obtained applying the length frequency distribution from the 2009 survey to the total biomass.
- Numbers at age were obtained applying commercial ALK from the eastern catches to the eastern echosurvey length distribution.
- 2011-2012 surveys covered only the Northern part of the area (about 52% of the total area), so the estimated biomass was raised to the total using an average percentage from previous years (2004-2010).

4.2.11.6.2 Geographical distribution patterns

Acoustic sampling transects and the total area covered in GSA 17 is shown in figure 4.2.11.6.2.1.

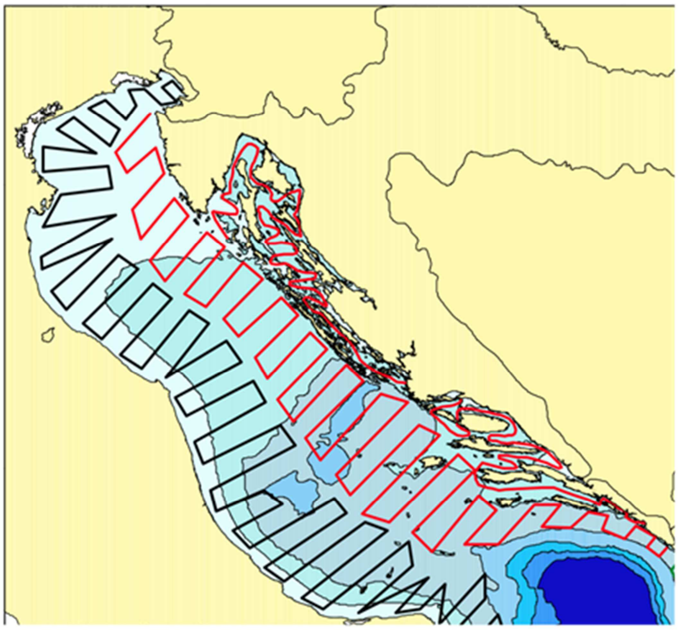


Figure 4.2.11.6.2.1. Acoustic transects for the western echosurvey (black tracks) and the eastern echosurvey (red tracks) for the GSA 17 only.

4.2.11.6.3 Trends in abundance & biomass

Biomass estimates from the acoustic surveys for the entire Adriatic Sea show a constant increase of anchovy until 2008, that is the highest point in the time series, and then a decrease reaching in 2013 the value of 473,970 t. The contribution of the eastern survey in the last three years of data is much lower respect to previous years (less than 10%), while the average contribution of the GSA 18 survey is about 11%.

Pooled total biomass in tons from eastern (GSA 17) and western (GSA 17 and GSA 18) echosurvey (2004-2013) is given in table 4.2.11.6.3.1. and it is shown in figure 4.2.11.6.3.1.

Table 4.2.11.6.3.1. Anchovy in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys.

	GSA17 (t)	GSA18 (t)	Total (t)
2004	302,130		302,130
2005	335,312		335,312
2006	627,226		627,226
2007	533,525		533,525
2008	858,497		858,497
2009	486,373	104,022	590,395
2010	642,184	50,692	692,876
2011	491,031	33,997	525,028
2012	540,434	72,785	613,219
2013	412,374	61,596	473,970

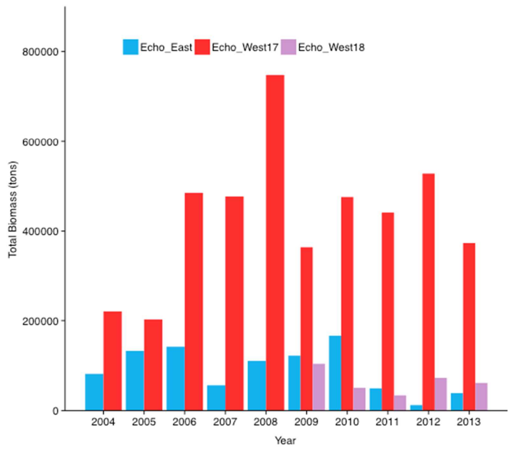


Figure 4.2.11.6.3.1. Anchovy in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys.

Data exploration of the tunning data are showed in the figures below (figs. 4.2.11.6.3.2. a,b,c). Even though the data showed generally a lack of internal consistencies, they were used to tune the assessment.

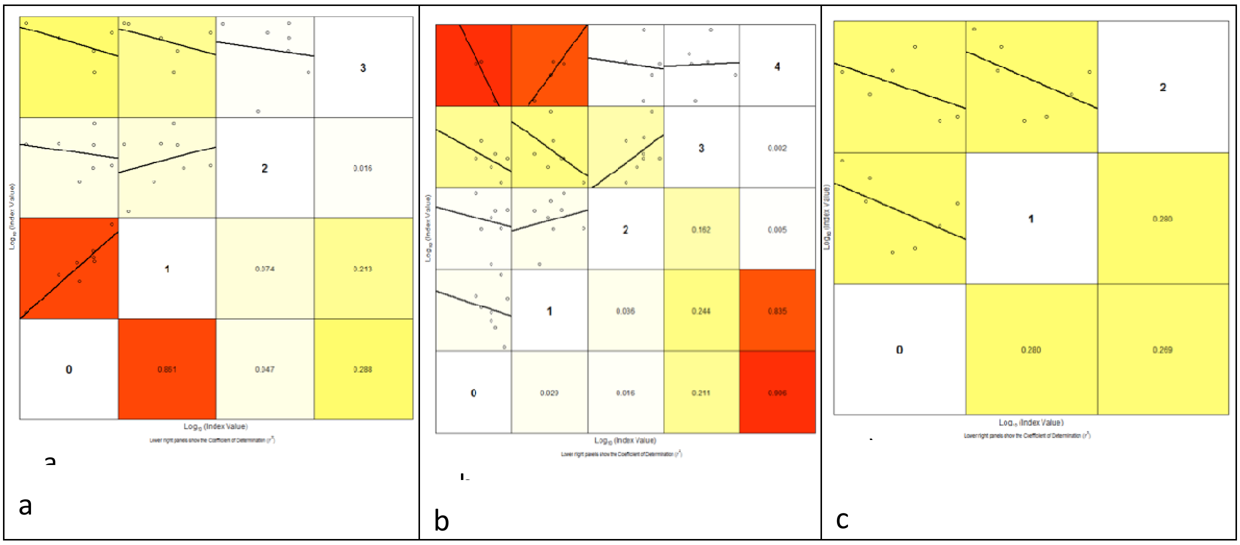


Figure 4.2.11.6.3.2. Internal consistency between ages for respectively: a) numbers at age from Western acoustic GSA 17; b) numbers at age from Eastern acoustic GSA 17; c) numbers at age from Western acoustic GSA 18.

The trend in numbers at age for the three surveys is shown in figure 4.2.11.6.3.3 a,b,c.

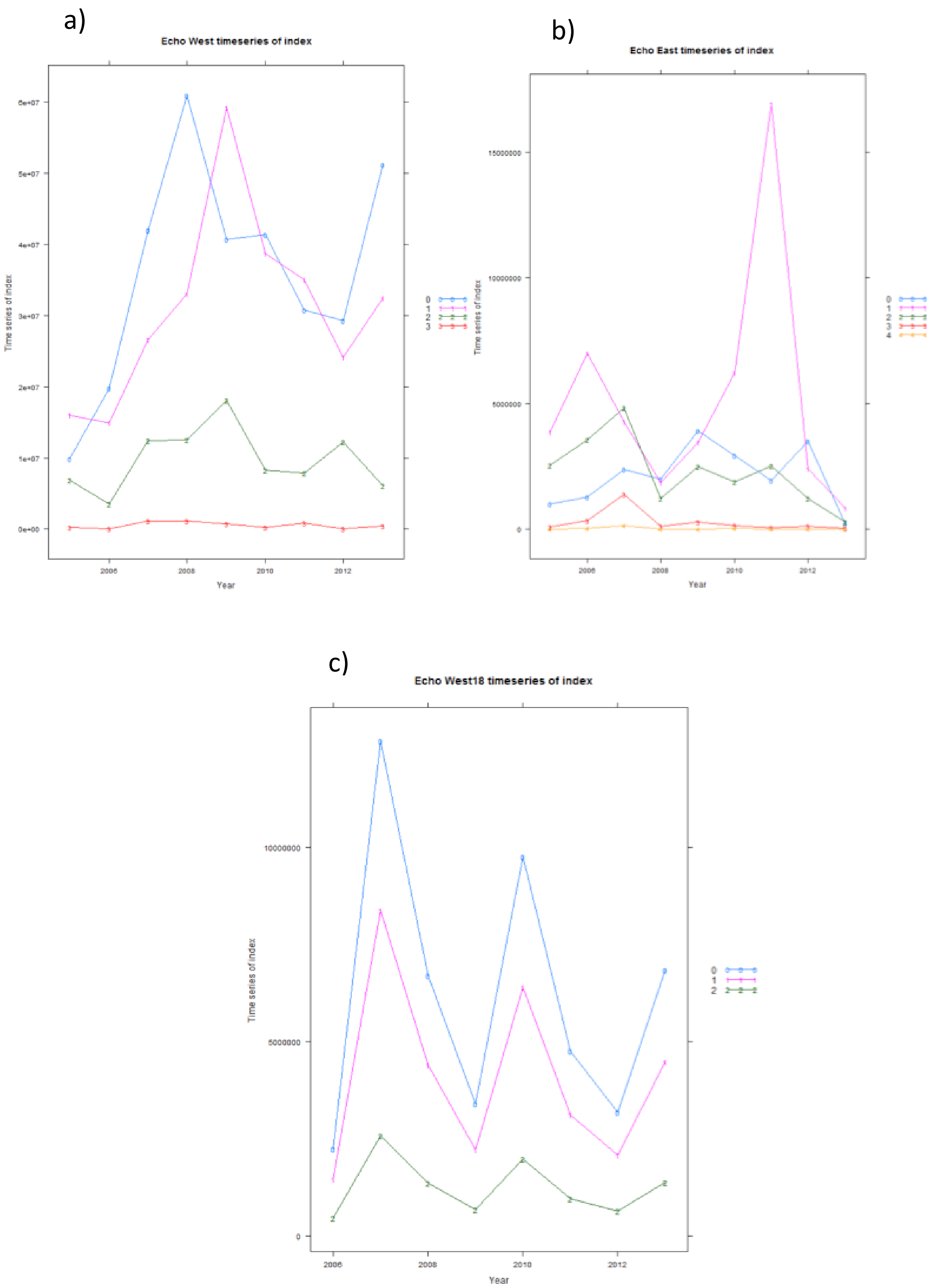


Figure 4.2.11.6.3.3. Trend in numbers at age for respectively: a) the Western acoustic GSA 17; b) the Eastern acoustic GSA 17; c) the Western acoustic GSA 18.

4.2.11.6.4 Trends in abundance by length or age

No specific analyses were conducted during EWG 14-09.

4.2.11.6.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.11.6.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.11.7 Assessment of historic stock parameters

State-space Assessment Model (SAM) has been performed from 1976 to 2013. Acoustic surveys were used to tune the assessment of anchovy in GSA 17-18.

4.2.11.7.1 Method: SAM

4.2.11.7.2 Justification

The stock of anchovy was asssessed using the State-space Assessment Model (SAM) (Nielsen *et al*., 2012) in FLR environment with data from 1975 to 2013. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell *et al*., 2007) in the form of the package "FLSAM". The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects.

Three tuning indices (two acoustic surveys covering respectively the western and eastern GSA 17, and one acoustic survey covering the western GSA 18) from 2004 to 2013 were used in the assessment.

Since the spawning takes place mostly in spring-summer (Zorica *et al*., 2013), the assessment was carried out taking into account a conventional birth date on the first of June (split-year), as in Santojanni *et al*. (2003). Consequently, all data were shifted by 6 months in order to have each year compounded by the time interval ranging from the first of June, up to May 31st of the following year; the tuning indices were shifted as well, therefore the survey performed in 2004 was used to tune the split year data for 2005, and so on.

All assessments are performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

4.2.11.7.3 Input parameters

Input data types and characteristics are given in Table 4.2.11.7.3.1.

Table 4.2.11.7.3.1. Anchovy in GSA 17-18. Input data for the SAM assessment.

	Age0	Age1	Age2	Age3	Age4	Age5
1976	320663	747420	522518	231029	62903	22570
1977	390148	838068	635979	350129	135028	58134
1978	665931	1397023	907752	432355	146534	57223
1979	1007419	1979711	1099808	391698	86668	32842
1980	622302	1596790	1203689	606076	194889	77782
1981	491437	1376970	1150754	614080	216091	86572
1982	591821	1087259	764637	389948	132400	49668
1983	536616	750484	438879	209195	65865	22330
1984	574066	644083	305498	136314	38146	10204
1985	880323	809870	293587	120766	26104	1806
1986	485777	635296	402273	250772	91325	9371
1987	129847	147116	99861	70055	38374	1456
1988	331540	162707	78789	32361	8481	1263
1989	556114	349931	157289	48879	8107	330
1990	427940	325826	179417	77664	16017	1041
1991	398250	411465	203664	92845	30370	6326
1992	492115	345560	208668	151931	86841	20870
1993	170121	367722	192828	121739	69485	37479
1994	380285	572102	238977	121359	53613	13988
1995	543948	1204617	523770	194487	70786	14208
1996	334282	1144724	585558	238229	99158	19164
1997	633342	1085748	530134	289848	129245	37810
1998	614970	1101426	598891	321137	141224	38454
1999	538670	905891	492427	268011	93070	13693
2000	916426	1182226	607554	149402	13232	0
2001	860490	1325570	528659	99457	7305	0
2002	522825	1080860	539141	96341	9512	0
2003	462070	1445496	640158	105017	8237	0
2004	1093561	1958415	674073	128852	13469	0
2005	1293912	1671959	1046008	261876	32285	4501
2006	892408	1641800	1114904	350107	57731	49640
2007	494403	1389677	2556065	570170	49806	15609
2008	510526	1371429	1787827	438744	60075	223
2009	446180	1693370	1495687	286923	32232	0
2010	614093	2113080	1057498	125741	18497	0
2011	863269	1700868	1027952	92525	5056	0
2012	687752	1744520	775277	37475	519	0
2013	460329	1074626	875177	95091	5201	0

Mean weight at age in the catches for the entire time series is shown in Figure 4.2.11.6.

All the configuration setting used in the SAM model this year are presented in the Table 4.2.11.7.3.2.

Table 4.2.11.7.3.2. Anchovy in GSA 17-18. Configuration settings for SAM model.

name	Final	Assessment					
range	min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
	0	4	4	1976	2013	1	2
fleets	Acoustic Survey for the western GSA 17 (2004-2013), the eastern GSA 17 (2004-2013) and the western GSA 18 (2009 to 2013)						
plus.group	TRUE						
age		0	1	2	3	4	
logN.vars		0	1	1	1	1	
catchabilities	Fleet1	1	1	2	3		
catchabilities	Fleet2	1	2	3	3	4	
catchabilities	Fleet3	1	2	3			
f.vars	catch	1	2	2	2	2	
obs.vars	Fleet1	1	1	2	3		
obs.vars	Fleet2	1	2	2	2	3	
obs.vars	Fleet3	1	1	2			
obs.vars	catch	1	1	2	2	3	

4.2.11.7.4 Results

SAM outputs are listed in table 4.2.11.7.4.1. Table 4.2.11.7.4.2. and 4.2.11.7.4.3. give respectively the fishing mortality at age by year and the stock numbers at age by year (in thousand).

Table 4.2.11.7.4.1. Anchovy in GSA 17-18. Main results of the anchovy assessment.

Year	Recruits Age 0 (Thousands) Mean	Recruits Age 0 (Thousands) Low	Recruits Age 0 (Thousands) High	Total biomass (tonnes) Mean	Total biomass (tonnes) Low	Total biomass (tonnes) High	Spawing biomass (tonnes) Mean	Spawing biomass (tonnes) Low	Spawing biomass (tonnes) High	Landings (tonnes) Mean
1976	139698907	105782494	184489738	1405635	1080896	1827937	385001	296869	499296	24077
1977	168088301	132663977	212971732	1647880	1315616	2064058	448651	358385	561651	29971
1978	176883167	142089827	220196305	1779779	1451604	2182148	486504	398028	594647	42916
1979	141385393	113587906	175985542	1470334	1206408	1791999	415817	342407	504965	53423
1980	97172664	77212537	122292662	1168230	951904	1433717	337055	275234	412761	53960
1981	68957436	53589601	88732288	756910	604614	947569	217945	173262	274152	46166
1982	56570601	43092262	74264678	643064	500683	825936	179512	138146	233266	38561
1983	56627200	42328010	75756924	646288	491534	849764	175606	132390	232930	27945
1984	48544915	35331448	66700033	594217	439113	804106	165215	120786	225986	24539
1985	32900552	22194032	48771954	453160	314535	652880	129832	88474	190524	30577
1986	23605729	14388548	38727357	363306	229072	576199	102642	62414	168796	29792
1987	28860949	18347157	45399643	362580	230405	570579	100509	61829	163385	9550
1988	43141674	29872856	62304188	425066	292858	616958	115151	77308	171519	7953
1989	50023327	35385929	70715490	529136	375517	745598	144062	100517	206471	13559
1990	50073376	36166361	69328040	574353	417430	790268	161458	115798	225122	14084

1991	48302796	35006713	66648933	624059	456937	852304	175606	127403	242048	16622
1992	58118815	43471930	77700636	681465	513656	904096	189662	141392	254411	18542
1993	70420854	54872957	90374147	727231	571656	925147	201995	157710	258717	14175
1994	90966330	74542769	111008396	843234	699719	1016186	233281	193094	281832	18836
1995	84140620	70447129	100495847	890911	760339	1043906	249447	213277	291751	33456
1996	69999594	59245598	82705607	871525	754170	1007141	243531	212178	279518	35137
1997	59948715	51047357	70402243	714973	624857	818086	199786	176207	226519	38292
1998	53919352	45925941	63304015	590662	516350	675670	161297	142163	183006	38638
1999	55450429	47462779	64782343	576655	503870	659955	152207	133912	173003	31825
2000	62457695	53364751	73100006	655399	570337	753148	167376	146348	191426	37684
2001	66919436	56676399	79013680	732340	631253	849615	186465	161612	215140	36938
2002	87399490	74116469	103063069	898966	773845	1044317	229808	199186	265138	31070
2003	117976971	100070498	139087602	1075181	925596	1248941	275406	239002	317354	32338
2004	139978584	118221152	165740256	1131438	973097	1315545	296559	257386	341693	41192
2005	158934067	129313365	195339729	1608801	1337165	1935619	422946	356341	502001	53370
2006	125523054	105190800	149785316	1397227	1193698	1635457	388481	333075	453103	56840
2007	97953164	82805129	115872319	1084902	939918	1252250	299839	262203	342876	65644
2008	86012225	73011988	101327236	865446	754297	992973	231422	203631	263007	52892
2009	83136966	70837242	97572335	723604	631138	829617	189473	165947	216333	49811
2010	76286001	64980738	89558138	696623	606059	800721	178439	155720	204471	52104
2011	75000100	61562852	91370278	744896	627528	884216	188151	159554	221874	48630
2012	60976555	43019291	86429603	560172	416886	752707	147857	111568	195950	40987
2013	57771146	34519316	96685152	616615	386366	984078	158895	100173	252040	32435

Year	Landings (tonnes) Low	Landings (tonnes) High	Yield / SSB (ratio) Mean	Yield / SSB (ratio) Low	Yield / SSB (ratio) High	Mean F ages 1-2 Mean	Mean F ages 1-2 Low	Mean F ages 1-2 High	Mean F ages 0-1	SoP (%)
1976	20896	27741	0.0625	0.0704	0.0556	0.1972	0.1330	0.2926	0.0582	1.00
1977	26878	33421	0.0668	0.0750	0.0595	0.2114	0.1493	0.2994	0.0591	1.00
1978	38833	47428	0.0882	0.0976	0.0798	0.2727	0.2005	0.3711	0.0817	1.00
1979	48856	58418	0.1285	0.1427	0.1157	0.3103	0.2383	0.4041	0.1142	1.00
1980	48633	59870	0.1601	0.1767	0.1450	0.3440	0.2648	0.4469	0.1187	1.00
1981	41147	51797	0.2118	0.2375	0.1889	0.4326	0.3262	0.5739	0.1497	1.00
1982	34733	42812	0.2148	0.2514	0.1835	0.4692	0.3401	0.6472	0.1727	1.00
1983	25230	30953	0.1591	0.1906	0.1329	0.4007	0.2805	0.5725	0.1472	1.00
1984	22300	27002	0.1485	0.1846	0.1195	0.3261	0.2248	0.4730	0.1272	1.00
1985	28244	33102	0.2355	0.3192	0.1737	0.3508	0.2383	0.5165	0.2030	1.00
1986	25488	34823	0.2903	0.4084	0.2063	0.4971	0.2949	0.8379	0.2382	1.00
1987	8185	11143	0.0950	0.1324	0.0682	0.2217	0.1138	0.4319	0.0703	1.00
1988	7175	8815	0.0691	0.0928	0.0514	0.1700	0.0913	0.3165	0.0622	1.00
1989	12518	14686	0.0941	0.1245	0.0711	0.2164	0.1355	0.3455	0.0895	1.00
1990	12951	15317	0.0872	0.1118	0.0680	0.1906	0.1226	0.2964	0.0733	1.00
1991	15326	18028	0.0947	0.1203	0.0745	0.1983	0.1338	0.2938	0.0880	1.00
1992	16842	20414	0.0978	0.1191	0.0802	0.1964	0.1332	0.2896	0.0792	1.00

1993	12708	15811	0.0702	0.0806	0.0611	0.1870	0.1280	0.2733	0.0638	1.00
1994	17108	20738	0.0807	0.0886	0.0736	0.2096	0.1494	0.2939	0.0807	1.00
1995	30337	36897	0.1341	0.1422	0.1265	0.3351	0.2611	0.4302	0.1343	1.00
1996	31956	38633	0.1443	0.1506	0.1382	0.3652	0.2925	0.4559	0.1414	1.00
1997	34981	41917	0.1917	0.1985	0.1850	0.4026	0.3300	0.4911	0.1674	1.00
1998	35114	42516	0.2395	0.2470	0.2323	0.5337	0.4472	0.6371	0.2080	1.00
1999	28997	34929	0.2091	0.2165	0.2019	0.6214	0.5173	0.7463	0.1898	1.00
2000	34687	40941	0.2251	0.2370	0.2139	0.8106	0.6792	0.9675	0.2460	1.00
2001	34120	39989	0.1981	0.2111	0.1859	0.7945	0.6664	0.9473	0.2472	1.00
2002	28323	34083	0.1352	0.1422	0.1285	0.6943	0.5702	0.8454	0.1792	1.00
2003	29557	35381	0.1174	0.1237	0.1115	0.6475	0.5292	0.7923	0.1722	1.00
2004	37918	44748	0.1389	0.1473	0.1310	0.5139	0.4209	0.6276	0.1724	1.00
2005	48873	58280	0.1262	0.1372	0.1161	0.4818	0.3962	0.5858	0.1285	0.98
2006	51452	62793	0.1463	0.1545	0.1386	0.4358	0.3447	0.5510	0.1076	0.99
2007	54376	79246	0.2189	0.2074	0.2311	0.6806	0.5642	0.8209	0.1134	0.98
2008	46558	60087	0.2286	0.2286	0.2285	0.7851	0.6700	0.9199	0.1473	0.98
2009	44519	55733	0.2629	0.2683	0.2576	1.0893	0.9457	1.2547	0.2138	0.98
2010	46784	58029	0.2920	0.3004	0.2838	1.2177	1.0729	1.3821	0.2837	1.00
2011	43972	53782	0.2585	0.2756	0.2424	1.4126	1.2369	1.6131	0.2593	1.03
2012	36851	45586	0.2772	0.3303	0.2326	1.0470	0.8645	1.2680	0.2658	1.01
2013	29009	36266	0.2041	0.2896	0.1439	1.0434	0.6562	1.6593	0.1975	1.01

Table 4.2.11.7.4.2. Anchovy in GSA 17-18. F at age estimated from 1976 to 2013.

	year						
age	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
0	0.005997	0.00609	0.009851	0.018553	0.016816	0.018731	0.027381
1	0.110350	0.112141	0.153601	0.209884	0.220535	0.280691	0.317969
2	0.284165	0.310709	0.391911	0.410697	0.467536	0.584616	0.620357
3	0.510089	0.603126	0.676888	0.644694	0.825505	0.936205	0.885671
4	0.510089	0.603126	0.676888	0.644694	0.825505	0.936205	0.885671
	1983	1984	1985	1986	1987	1988	1989
0	0.024975	0.031301	0.070623	0.053993	0.011998	0.020121	0.029063
1	0.269335	0.22313	0.335444	0.422317	0.128632	0.104215	0.149883
2	0.532129	0.429017	0.366191	0.571889	0.314680	0.23584	0.282833
3	0.750182	0.64490	0.616979	0.863311	0.478313	0.302069	0.359659
4	0.750182	0.64490	0.616979	0.863311	0.478313	0.302069	0.359659
	1990	1991	1992	1993	1994	1995	1996
0	0.022467	0.021658	0.021954	0.006415	0.010925	0.016822	0.012623
1	0.124208	0.154247	0.136436	0.121105	0.150379	0.25183	0.270117
2	0.257046	0.242271	0.256302	0.252865	0.268770	0.418458	0.460271
3	0.420067	0.405851	0.509676	0.478954	0.497316	0.638707	0.775591
4	0.420067	0.405851	0.509676	0.478954	0.497316	0.638707	0.775591
	1997	1998	1999	2000	2001	2002	2003

0	0.027593	0.029942	0.025658	0.038531	0.033699	0.015714	0.010345
1	0.307279	0.386115	0.353915	0.453568	0.460708	0.342631	0.334138
2	0.497898	0.68137	0.888821	1.167635	1.128309	1.045966	0.960946
3	0.967676	1.39197	2.015123	1.970643	1.706032	1.591027	1.389828
4	0.967676	1.39197	2.015123	1.970643	1.706032	1.591027	1.389828
	2004	2005	2006	2007	2008	2009	2010
0	0.020366	0.021318	0.018602	0.013279	0.015505	0.014118	0.021123
1	0.324393	0.235699	0.196499	0.213504	0.27904	0.41354	0.546233
2	0.703512	0.727799	0.675137	1.147631	1.291133	1.76514	1.889156
3	1.294779	1.381169	1.484978	1.816297	2.12266	2.111651	2.445428
4	1.294779	1.381169	1.484978	1.816297	2.12266	2.111651	2.445428
	2011	2012	2013				
0	0.030176	0.029597	0.02098				
1	0.488503	0.502028	0.374105				
2	2.336631	1.591903	1.712749				
3	2.984105	1.824307	2.134324				
4	2.984105	1.824307	2.134324				

Table 4.2.11.7.4.3. Anchovy in GSA 17-18. Stock numbers at age from 1976 to 2013.

	year					
age	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
0	1.40E+12	1.68E+12	1.77E+12	1.41E+12	9.72E+11	6.90E+11
1	1.17E+11	1.30E+11	1.59E+11	1.68E+11	1.31E+11	9.02E+10
2	3.07E+10	3.49E+10	3.87E+10	4.59E+10	4.55E+10	3.51E+10
3	7.92E+09	1.03E+10	1.14E+10	1.16E+10	1.36E+10	1.28E+10
4	3.36E+09	3.46E+09	3.83E+09	3.93E+09	4.15E+09	3.97E+09
	1982	1983	1984	1985	1986	1987
0	5.66E+11	5.66E+11	4.85E+11	3.29E+11	2.36E+11	2.89E+11
1	6.37E+10	5.13E+10	5.26E+10	4.51E+10	2.86E+10	2.04E+10
2	2.26E+10	1.53E+10	1.29E+10	1.43E+10	1.08E+10	6.02E+09
3	8.70E+09	5.39E+09	3.97E+09	3.72E+09	4.54E+09	2.68E+09
4	3.33E+09	2.52E+09	1.90E+09	1.56E+09	1.45E+09	1.28E+09
	1988	1989	1990	1991	1992	1993
0	4.31E+11	5.00E+11	5.01E+11	4.83E+11	5.81E+11	7.04E+11
1	2.72E+10	4.03E+10	4.59E+10	4.64E+10	4.42E+10	5.31E+10
2	5.93E+09	8.34E+09	1.15E+10	1.36E+10	1.32E+10	1.27E+10
3	1.92E+09	2.09E+09	2.83E+09	3.95E+09	4.81E+09	4.52E+09
4	1.24E+09	1.18E+09	1.17E+09	1.34E+09	1.80E+09	2.03E+09
	1994	1995	1996	1997	1998	1999
0	9.10E+11	8.41E+11	7.00E+11	5.99E+11	5.39E+11	5.55E+11
1	6.70E+10	8.61E+10	7.80E+10	6.58E+10	5.46E+10	4.90E+10
2	1.56E+10	1.96E+10	2.23E+10	1.98E+10	1.63E+10	1.22E+10
3	4.38E+09	5.34E+09	5.76E+09	6.27E+09	5.38E+09	3.67E+09

4	2.07E+09	2.00E+09	1.98E+09	1.82E+09	1.57E+09	8.78E+08
	2000	2001	2002	2003	2004	2005
0	6.25E+11	6.69E+11	8.74E+11	1.18E+12	1.40E+12	1.59E+12
1	5.11E+10	5.65E+10	6.02E+10	8.14E+10	1.12E+11	1.29E+11
2	1.15E+10	1.08E+10	1.18E+10	1.42E+10	1.94E+10	2.71E+10
3	2.22E+09	1.58E+09	1.55E+09	1.84E+09	2.39E+09	4.31E+09
4	3.06E+08	1.77E+08	1.61E+08	1.75E+08	2.52E+08	3.65E+08
	2006	2007	2008	2009	2010	2011
0	1.26E+12	9.80E+11	8.60E+11	8.31E+11	7.63E+11	7.50E+11
1	1.49E+11	1.17E+11	9.09E+10	7.94E+10	7.82E+10	7.00E+10
2	3.40E+10	4.20E+10	3.18E+10	2.29E+10	1.74E+10	1.50E+10
3	5.83E+09	7.82E+09	5.95E+09	3.92E+09	1.74E+09	1.17E+09
4	5.95E+08	7.37E+08	7.00E+08	4.02E+08	2.64E+08	8.76E+07
	2012	2013				
0	6.10E+11	5.78E+11				
1	6.91E+10	5.54E+10				
2	1.42E+10	1.39E+10				
3	6.37E+08	1.29E+09				
4	3.17E+07	5.43E+07				

The average fishing mortality for ages 1-2 (Figure 4.2.11.7.4.1) starts increasing in 1994, reaching the maximum value of 1.4 in 2011. The estimate for 2013 is equal to 1.04. The mid year spawning stock biomass (figure 4.2.11.7.4.1., top) fluctuates from the highest values in 1978 (about 486,504 tons) to a minimum in 1987 of 100,509 tons. After that the stock is constantly increasing: in 2005 reach the highest value registered in the last decade (422,946 tons) but decreased thereafter to around 160000 t in 2013. The recruitment (age 0 – figure 4.2.11.7.4.1, bottom) fluctuates around a minimum value of 23,605,729 thousands specimen in 1986, to a maximum value of 177,000,000 in 1978. From 1986 the estimated recruitment is constantly increasing to decrease thereafter reaching around 57700 millions individual in 2013.

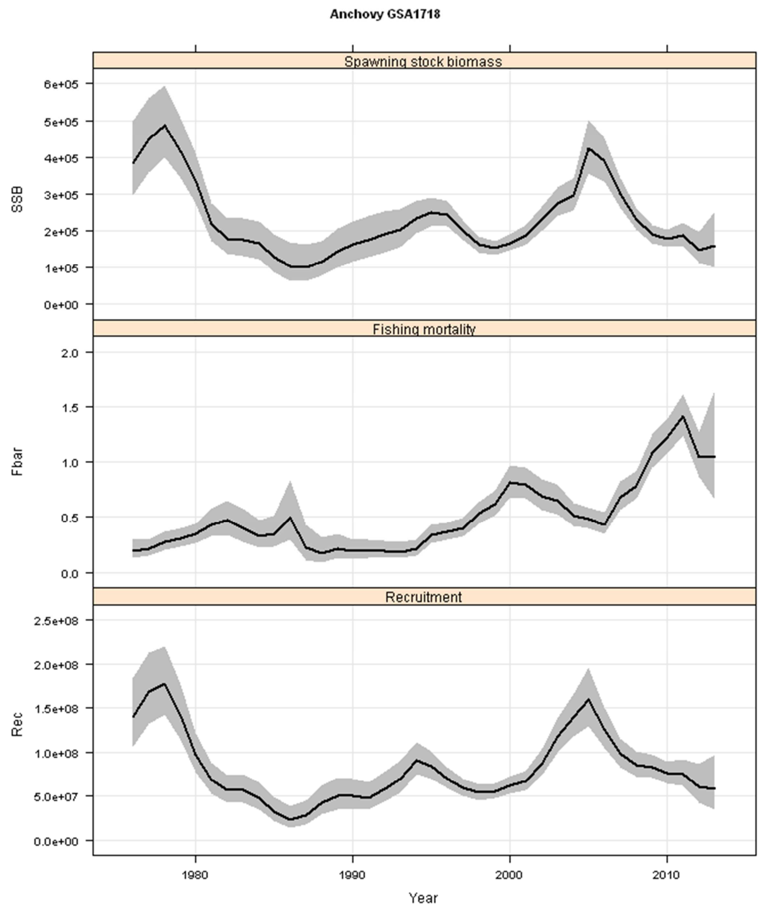


Figure 4.2.11.7.4.1. Anchovy in GSA 17-18. Mid year Spawning Stock Biomass (SSB) in tons (on top). F (age 1 to 2) (middle); recruitment (as thousands individuals)(bottom); 95% confidence intervals are shown.

Selectivity by age classes is plotted in figure 4.2.11.7.4.2. The plots show a constantly increasing selectivity up to age 3 and 4 for all the oldest pentads: even though quite unrealistic, it was not possible to improve this pattern. In the last 2 pentads the pattern improves, and it considered more reasonable.

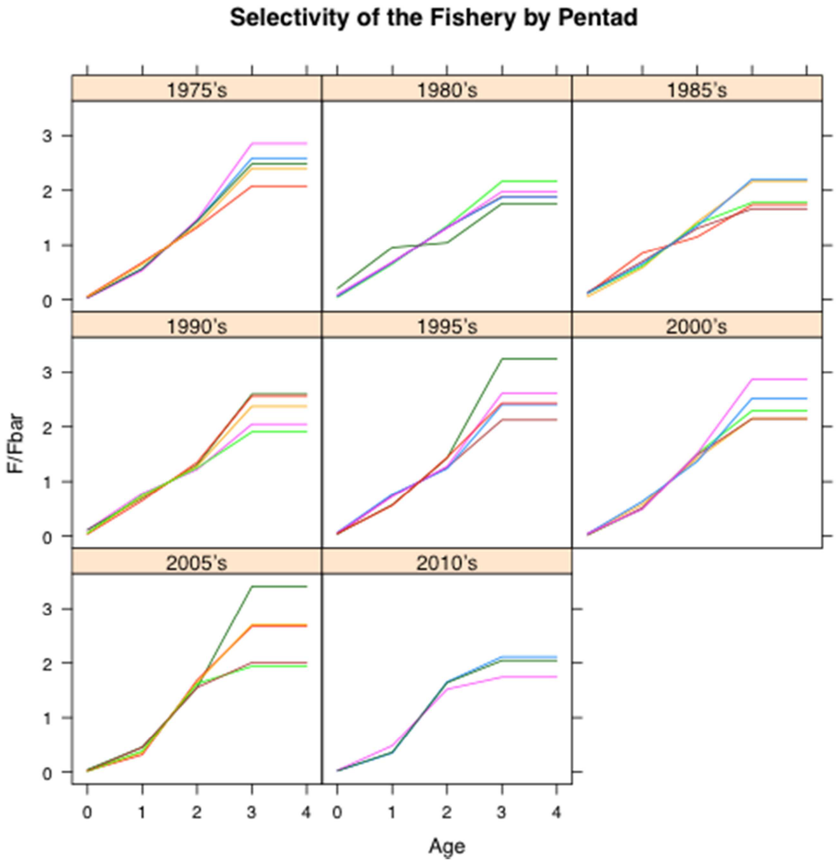


Figure 4.2.11.7.4.2. Anchovy in GSA 17-18. Selectivity at age by pentads as estimated by the SAM model.

On the overall catch residuals did not show any trend. On the other hand, survey data showed strong patterns in the residuals for all ages and years. In the figures below only age 1 is shown as example of the perfect fitting in the catches, and of the overall bad fitting of the tuning indices (figure 4.2.11.7.4.3 a, b, c, d).

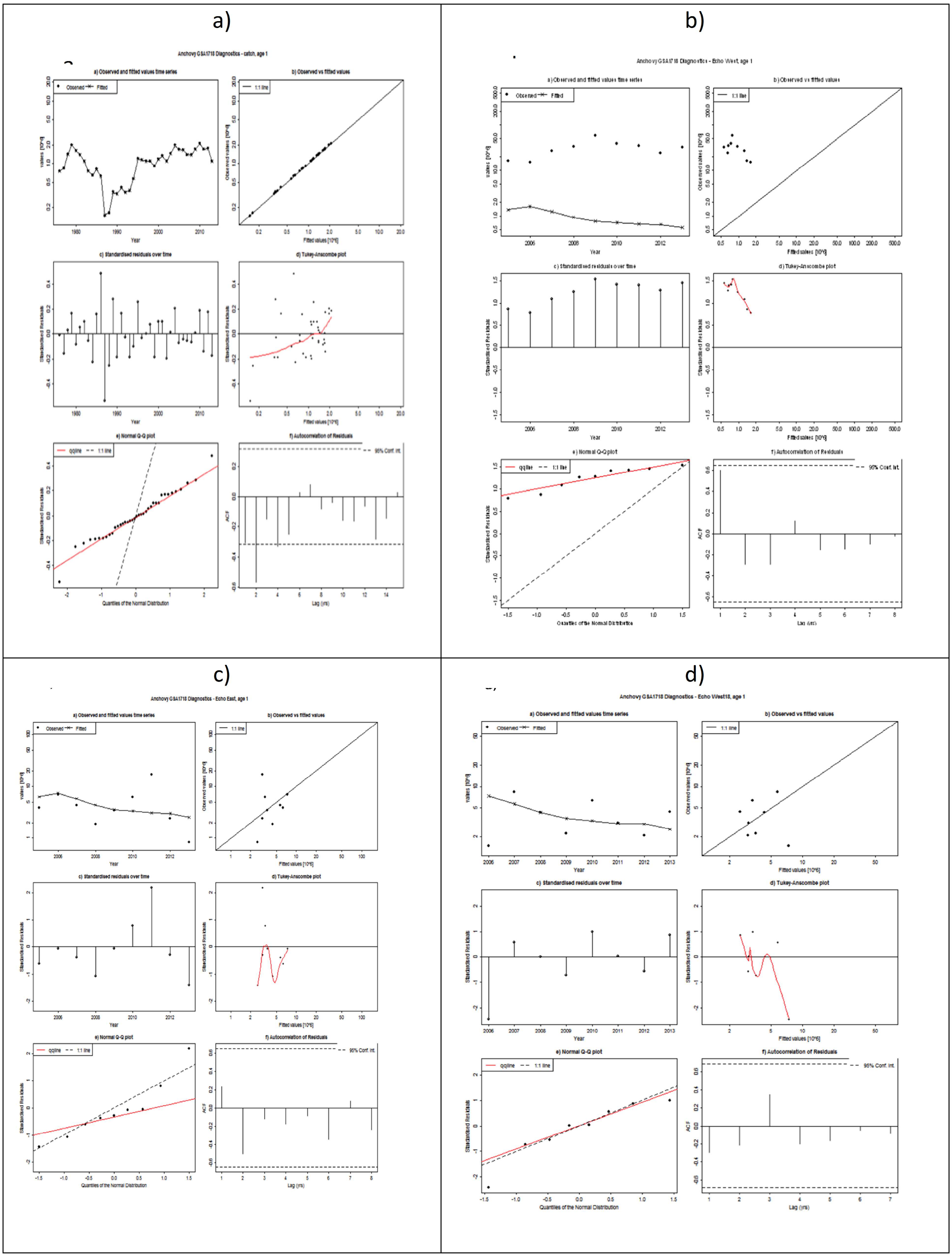


Figure 4.2.11.7.4.3. Anchovy in GSA 17-18. Diagnostic in catch and survey age structure residuals (age 1) for respectively: a) total catches age 1; b) western echosurvey GSA 17 age 1; c) Eastern echosurvey GSA 17 age 1; d) western echosurvey GSA 18 age 1.

Also, observation variances by input data (fig. 4.2.12.7.4.4.) showed that model is overfitting the catch data and among the surveys is practically not using Echo West GSA 17 as the variability in the input data is high.

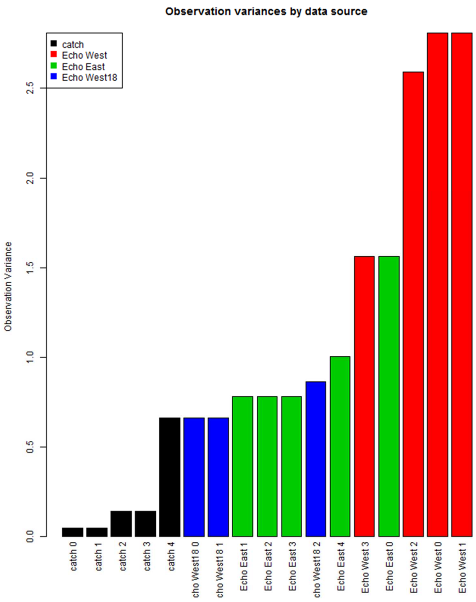


Figure 4.2.11.7.4.4. Anchovy in GSA 17-18. Plot of the observation variances by input data.

4.2.11.8 Long term prediction

Medium term simulations performed are reported in section 4.10.4

4.2.11.9 Data quality

An accurate analysis of the available data for anchovy stock in GSA 17-18 detected several issues and strong inconsistencies. All the identified problems are listed below:

– <u>Split-year assumption:</u> right now all the time series is in split year, this implies several complications, together with the fact that the last year of survey is not used in the assessment.
– <u>Internal inconsistency of acoustic surveys</u>, in particular for the western acoustic GSA 18. The age structure of the three acoustic surveys used is internally inconsistent, i.e. the cohorts are not well identified through time (with few exceptions, i.e. 0-1 western acoustic GSA 17 and 2-3 eastern acoustic GSA 17). Besides, for the present assessment in which the three surveys have been used independently from each other, it was necessary to aggregate some age classes, due to gaps in the age structure. This internal inconsistency implied a high-observed variance in the surveys data, which therefore were assigned a low weight from the model with a consequently overfitting of the catch data.
– <u>Total landings before 2000 have been split into Length Frequency Distribution using biological data from the Italian side alone</u>: the entire time series before 2000 has been disaggregated into numbers at age using biological data from the western Adriatic area, without taking into account the different length structure in the catches between the

western and the eastern catches. An attempt to apply a common ALK to the whole time series of raised length frequency distribution produced a completely different catch structure, implying also difference in the total landings.

– Fluctuations in the weight at age. The weight at age for 2010 and 2011 in particular for ages 2, 3 and 4 show unexpected peaks. Besides, the really high weight at age of ages 3 and 4 estimated in the late eighties seems quite unreliable (Figure 4.2.11.9.1).

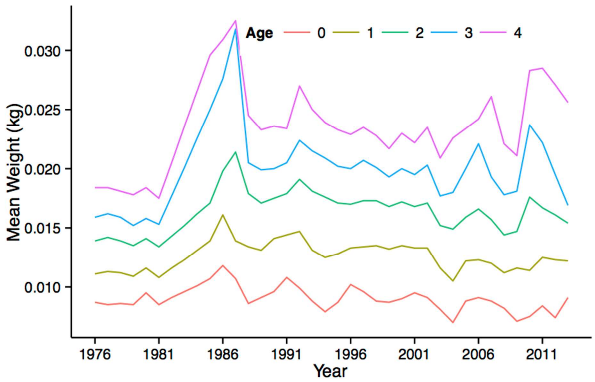


Figure 4.2.11.9.1. Anchovy in GSA 17-18. Mean weight at age (kg) of the catch at age from 1976 to 2013.

– No information on length or age structure of GSA 18: no biological information are available before 2004 for GSA 18, therefore all the data used for the present assessment had to be reconstructed.

Age structure between eastern and western catches and survey has been investigated as well, and seems coherent between the two sides (Fig. 4.2.11.9.2.).

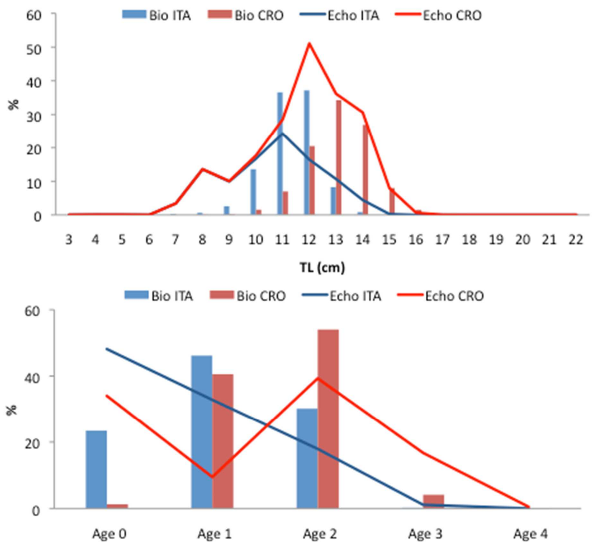


Figure 4.2.11.9.2. Anchovy in GSA 17-18. Length frequency distribution (on top) and age structure (at the bottom) in catch matrix and survey numbers at age for 2013 from western and eastern data.

Suggested Roadmap:

EWG 14-09 suggests that:

- Move from split-year data to calendar-year data: this step will simplify the calculations limiting the errors, and it will allow using the most recent survey index available.
- Length Frequency Distribution from eastern catches should be applied to the eastern landings before 2000, and the new structure in the catch should be compared with the old one.
- A review of the age-structure of acoustic should be considered, to improve the internal consistency of the survey.
- From the previous steps, changes in the weight at age matrix will follow. The reliability of the new weight at age matrix should be evaluated; if not satisfactory, the reasons behind the high fluctuations observed in the weight at age matrix should be identified.

4.2.11.10 Scientific advice

The stock spawning biomass is estimate to be below B_{lim} and F is above F_{MSY}.

4.2.11.11 Short term considerations

4.2.11.11.1 State of the spawning stock size

The SAM analyses indicate that the anchovy stock size fluctuated over the time period examined. Namely, maximum values of the SSB were obtained in 1978 (around 486,500 t). After that, the stock started to decline reaching a minimum level in 1987 (around 100,500 t). In the following years the stock started recovering until 2005, when the biomass reached its second maximum (SSB at 422,950 tons). From 2005, the stock started to decline again, reaching in 2013 a SSB biomass level of 158,900 tons.

Biomass reference points were estimated from the SAM results using the approach of a typical medium term projection, but including uncertainty in the choice of the stock recruitment model. The biomass of anchovy (SSB mid year excluding age 0 individuals = 38,960 t) in 2013 is slightly below the limit reference points estimated through the medium term projection (B_{lim} excluding age 0 individuals = 42,550 t).

4.2.11.11.2 State of recruitment

SAM model estimates show fluctuations in the number of recruits since the beginning of the time series, similar to those observed for the SSB. The recruitment (age 0 – figure Figure 4.2.11.11, bottom) fluctuates around a minimum value of 23,600 milions individuals in 1986, to a maximum value of 176,890 milions individuals in 1978. A second peak was registered in 2005, with a value of 158,950 milions individuals.

4.2.11.11.3 State of exploitation

Based on SAM results, the current F (1.04) is larger than F_{MSY} (0.50), which indicates that anchovy in GSA 17 is exploited unsustainably.

4.2.11.12 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.12 STOCK ASSESSMENT OF SARDINE IN GSA 17-18

4.2.12.1 Stock Identification

Although there is some evidence of differences on a series of morphometric, meristic, serological and ecological characteristics, the lack of genetic heterogeneity in the Adriatic stock has been demonstrated through allozymic and mitochondrial DNA (mtDNA) surveys (Carvalho *et al.*, 1994) and through sequence variation analysis of a 307-bp cytochrome b gene (Tinti *et al*., 2002). Also, Ruggeri *et al*. (2013) supports the hypothesis of one stock on the basis of microsatellites DNA, even if suggests that some of the genetic homogeneity observed could be apparent and the identification of a subtle structuring in sardine population could be limited by technical difficulties and by the incomplete knowledge of molecular mechanisms. Therefore, in this year assessment, and according to the fact that a lot of vessels registered in GSA 18 fish in GSA 17, it was decided to merge the two GSAs.

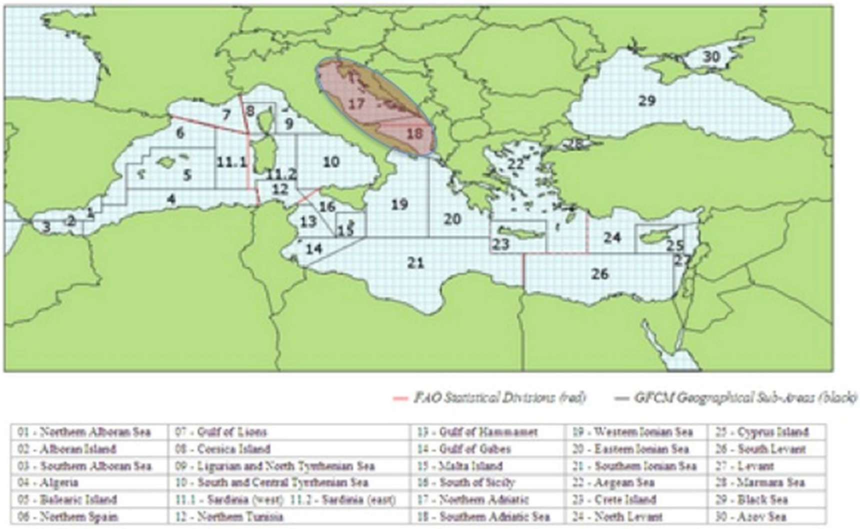


Figure 4.2.12.1.1. Geographical location of GSA 17 - 18

4.2.12.2 Growth

The growth of sardine in the Adriatic Sea was assessed using historical growth parameters (Sinovčić, 1984). Age-length and age-weight keys were produced using otolith readings and actual length-weight parameters. The growth parameters used during the EWG 14-09 were:

Table 4.2.12.2.1. Sardine in GSA 17-18. Von Bertalanffy growth parameters.

Growth parameters	L_{inf}	k	t_0
Both sexes	20.5	0.46	-0.5

4.2.12.3 Maturity

Table 4.2.12.3.1. Sardine in GSA 17-18. Proportion of mature specimens at age.

PERIOD	Age	0	1	2	3	4	5
1975-2013	Prop. Matures	0.75	1.00	1.00	1.00	1.00	1.00

4.2.12.4 Natural mortality

Table 4.2.12.4.1. Sardine in GSA 17-18. Natural mortality vector by age from Gislason et al. (2010).

PERIOD	Age	0	1	2	3	4	5	6
1975-2013	M	2.51	1.10	0.76	0.62	0.56	0.52	0.50

4.2.12.5 Fisheries

4.2.12.5.1 General description of Fisheries

Sardine is a commercially very important species in the Adriatic Sea: it is targeted mainly by pelagic trawlers (Italy) and purse seiners (Croatia, Slovenia, Italy). The number of vessels targeting this species is around 400. Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17. In Montenegro most of the catches are originated from small-scale beach seine fisheries from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are likely to be rather low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small .

4.2.12.5.2 Management regulations applicable in 2013

A multi–annual management plan for small pelagic fisheries in the Adriatic Sea has been established by the General Fisheries Commission for the Mediterranean (GFCM) in 2012. Besides, Italy has been enforcing for years a general regulation concerning the fishing gears and since 1988 a suspension (about one month) of fishing activity of pelagic trawlers in summer. A closure period is observed from 15th December to 15th January from the Croatian purse seiners. A closure period of 60 days and a closure period of 42 days was endorsed from the Italian fleet respectively in 2011-2012 and in 2013.

4.2.12.5.3 Catches

4.2.12.5.4 Landings

Concerning GSA 17, landings and catch at age data from 2004 were available through the DCF database for Italy and Slovenia. For Croatia, data from 2004 to 2012 were available through the Croatian experts, since Croatia is participating to the Data Collection Program starting in 2013. Nevertheless, an error was detected in the DCF database for 2013 data, which were thus provided directly by the invited experts at EWG 14-09. Data before 2004 were provided for all the countries from the experts involved in the assessment.

Concerning GSA 18, the data were available through the DCF program starting in 2005; before that, the data were reconstructed as follows:

- 1975-1994: total landings for maritime compartment from the Italian National Institute of Statistic. The data were available until 1999, but in the last 5 years of data, the landings showed an unreliable pattern, with high peaks. A similar behavior was evident also for the landings of another small pelagic, i.e. anchovy, and it was therefore ascribed to some sampling issues (e.g. changing in the sampling methodology). For this reason the data from 1995 to 1999 were not included.
- 1995-2004: an average proportion of catches in GSA 18 over the catches in GSA 17 was estimated from the total landings available from the sampling program from 2006 to 2013 (i.e. GSA 18/GSA 17 = 12.3%). This ratio was used to derive an estimate of GSA 18 landings from GSA 17 for the period 1995-2004.
- In 2010 data were also not available for sardine, therefore the same procedure applied for the years from 1995 to 2004 was used.

The reconstructed landings for GSA 18 together with the landings for GSA 17 are presented in figure 4.2.12.5.4.1. To account for the landings of Albania and Montenegro the FAO estimates (from the FAO database) where used: the average amount from 2004 to 2013 is about 150, therefore the values are included in the plot below together with GSA 18 estimates. A SOP correction has been applied to all the landings and numbers at age matrix (SOP correction on the average less than 10%).

The stock started to decrease in the late eighties reaching a minimum in 2005 with 19,000 tons. In the last 8 years the Croatian catches grew high, reaching the maximum of the entire time series in 2013 with about 52,931 tons (about 83% of the overall catches).

Figure 4.2.12.5.4.1. Sardine in GSA 17-18. Total reconstructed landings (in tons) by GSA from 1975 to 2013.

A proportion of LDF from GSA 18 in the period 2005-2013 has been used to split the total landings into numbers at length (Figure 4.2.12.5.4.2). Then, an average ALK from the port of San Benedetto (which is considered representative of the age distribution of GSA 18) has been applied to estimate the numbers at age (Figure 4.2.12.5.4.3).

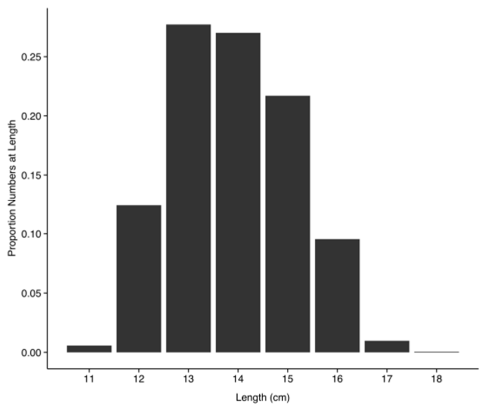


Figure 4.2.12.5.4.2. Sardine in GSA 17-18. Length frequency distribution proportion from GSA 18 catches 2005-2013 applied to the GSA 18 total landings from 1975 to 2004

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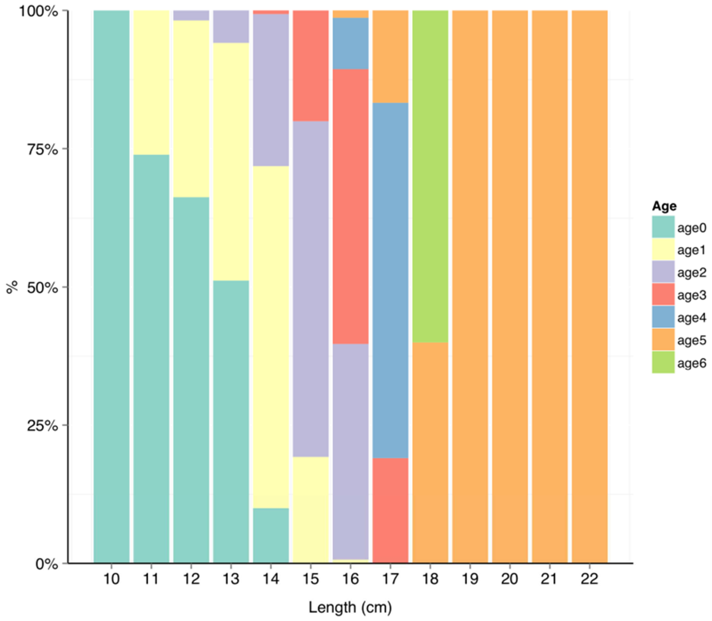

Figure 4.2.12.5.4.3. Sardine in GSA 17-18. Age-Length Key from port of San Benedetto applied to the GSA 18 length frequency distribution to estimate the numbers at age.

The final catch at age for GSA 17-18 with the trend in cohorts is presented in figure 4.2.12.5.4.4. Each plot represents the number of fish of each age born in the same year. Age 1 can be identified as the first fully recruited age in most of the years.

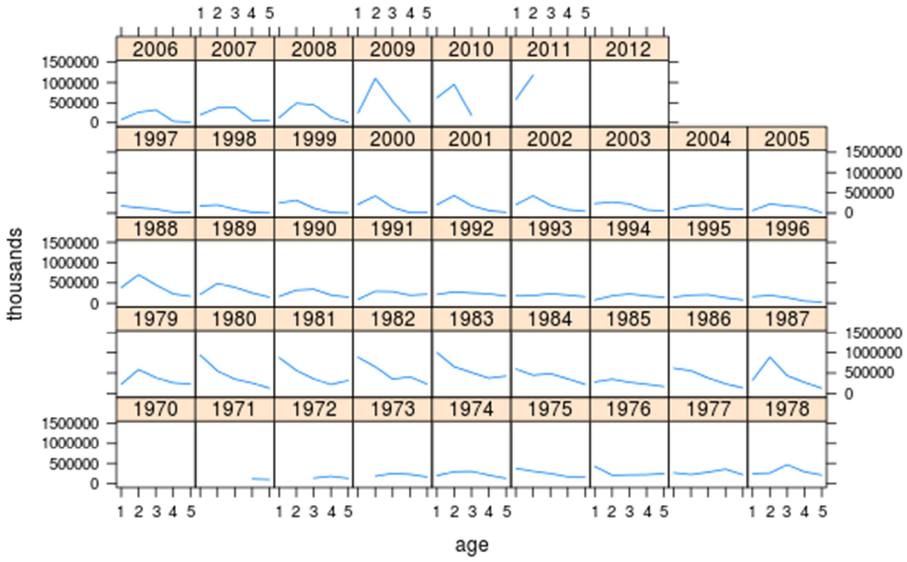

Figure 4.2.12.5.4.4. Sardine in GSA 17-18. Numbers at age (thousands) of the catch at age.

The following table shows the annual landings (t) of sardine in the GSA 17-18.

Table 4.2.12.5.4.1. Sardine in GSA 17-18. Total landings (tons) by year for the entire GSA 17-18.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1975	32874	**1985**	73350	**1995**	32180	**2005**	19576
1976	44997	**1986**	77389	**1996**	36860	**2006**	19074
1977	52715	**1987**	69122	**1997**	34617	**2007**	19597
1978	43062	**1988**	65323	**1998**	32537	**2008**	24760
1979	40300	**1989**	67885	**1999**	25276	**2009**	32402
1980	47344	**1990**	60170	**2000**	22510	**2010**	31965
1981	90387	**1991**	51919	**2001**	21039	**2011**	53242
1982	82057	**1992**	42361	**2002**	23528	**2012**	56262
1983	81222	**1993**	44911	**2003**	22242	**2013**	63612
1984	90200	**1994**	39402	**2004**	24617		

The weight at age of the catches is shown in Figure 4.2.12.5.4.5. In 2011 and 2012 the average weight for all the ages had unexpected fluctuations (data not shown). Therefore, an average of 2010 and 2013 data has been applied for all ages for 2011 and 2012 (Figure 4.2.12.5.4.5).

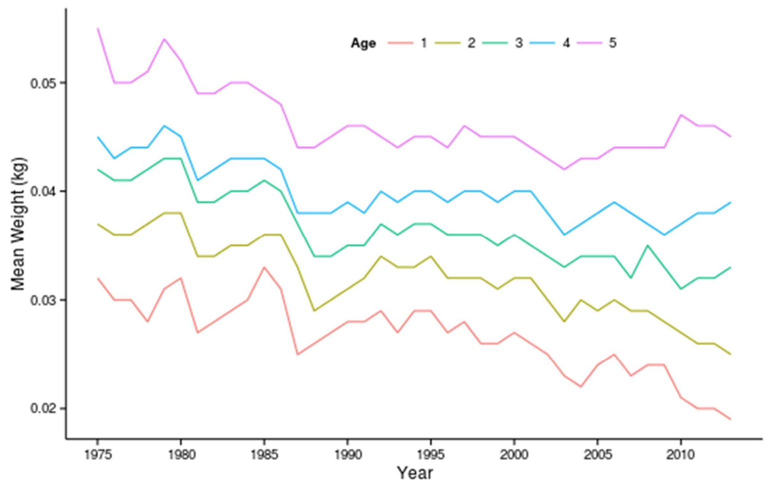

Figure 4.2.12.5.4.5. Sardine in GSA 17-18. Mean weight at age (kg) of the catch at age used in the assessment.

4.2.12.5.5 Discard

Discard was included in the total catches of the Italian fleet and the Slovenian fleet. The data available start, respectively, from 2011 and from 2005 (Figure 4.2.12.5.5.1). In 2011 discard estimate was available for GSA 18 as well and therefore included in the analysis. On the overall the discard is low, being on average equal to 8.5% for the Italian fleet of GSA 17 (average 2011-2013), and to 2.7% for the Slovenian fleet of GSA 17 (average 2005-2013).

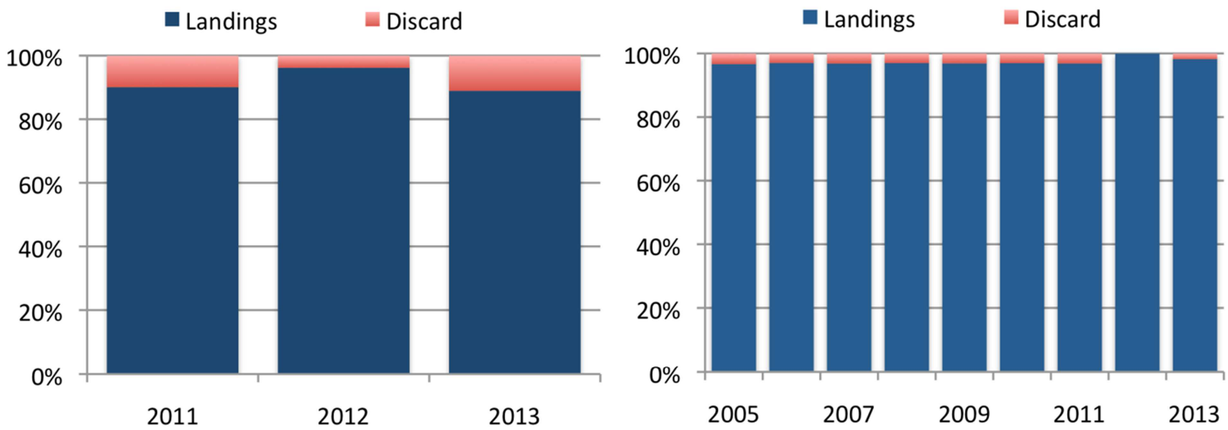

Figure 4.2.12.5.5.1. Proportion of discard and landings for the Italian fleet (to the left) and the Slovenian fleet (to the right) of GSA 17.

4.2.12.5.6 Fishing Effort

The number of vessels from Italy, Croatia and Slovenia targeting this species is around 400. In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small.

4.2.12.6 Scientific surveys

4.2.12.6.1 Methods

MEDIAS

Echosurveys were carried out from 2004 to 2013 for the entire GSA 17 and 18. In the western part the acoustic survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area), and in the MEDIAS framework since 2009. In the GSA 18, echosurvey was carried out from 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON untill 2012 and latter on thorught DCF. The data from the two surveys in GSA 17 have been used as two independent tuning indices in the form of numbers-at-age from 2004 to 2012. An inconsistency was found in the age matrix of the western acoustic survey: in fact, in 2009 age 5 was equal to 0 individuals, while age 6 was equal to about 18,000 specimens; besides, in all the years (except in 2009) no ages 5 or 6

were recorded. Therefore, it was decided to group age 6 from 2009 to age 4 from the same year.
The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2012).
Below the data available for each survey are summarized.
Western Echosurvey:
GSA17

- Length frequencies distribution available from 2004 onward (no LFD for Mid Adriatic in 2004, so the biomass at length in 2004 was assumed equal to the proportion of biomass at length in the 2005 Mid Adriatic survey);
- ALK available from 2009;
- Numbers at age for 2004 to 2008.

GSA18

- Length frequencies distribution available from 2009 onward.
- Numbers at age from 2009 to 2013.

Eastern Echosurvey:

- Length frequencies distribution available from 2009.
- No ALKs available.
- Numbers at length from 2004 to 2008 were obtained applying the length frequency distribution from the 2009 survey to the total biomass.
- Numbers at age were obtained applying commercial ALK from the eastern catches to the eastern echosurvey length distribution.
- 2011-2013 surveys covered only the Northern part of the area (about 52% of the total area), so the estimated biomass was raised to the total using an average percentage from previous years (2004-2010).

4.2.12.6.2 Geographical distribution
Acoustic sampling transects and the total area covered in GSA 17 is shown in figure 4.2.12.6.2.1.

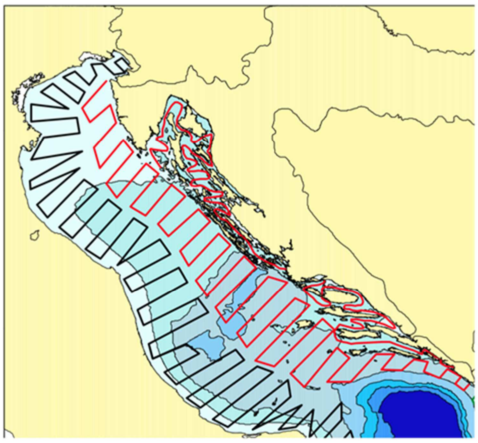

Figure 4.2.12.6.2.1. Acoustic transects for the western echosurvey (black tracks) and the eastern echosurvey (red tracks) for the only GSA 17.

4.2.12.6.3 Trends in abundance & biomass

Biomass estimates from the acoustic surveys for the entire Adriatic Sea show a constant increase of the occurrence of sardine on the western side of the Adriatic: in the first years, the western survey was contributing to about 23% of the biomass estimated from acoustic, while between 2011 and 2013 the average contribution was of 63%. The total biomass estimated in GSA 18 is extremely high in 2013, contributing to almost 20% of the total biomass.

Total biomasses of sardine in tons from eastern (GSA 17; 2004-2013) and western (GSA 17; 2004-2013 and GSA 18; 2009-2013) echosurveys are given in table 4.2.12.6.3.1 and are shown in Figure 4.2.12.6.3.1

Table 4.2.12.6.3.1. Sardine in GSA 17-18. Total biomass (tons) estimated by the acoustic surveys.

	GSA17	GSA18	TOT
2004	287,675		287,675
2005	140,082		140,082
2006	312,793		312,793
2007	217,897		217,897
2008	272,370		272,370
2009	365,939	39,409	405,348
2010	258,130	27,461	285,591
2011	483,224	73,361	556,585
2012	207,637	27,271	234,909
2013	430,647	101,428	532,074

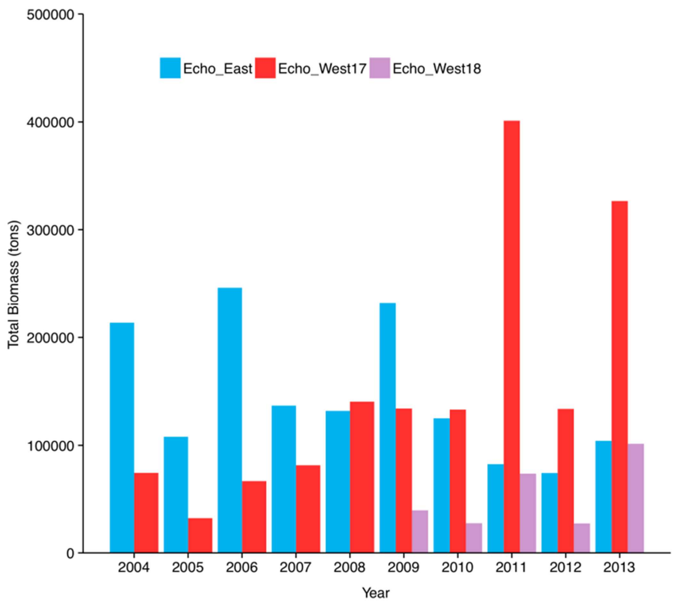

Figure 4.2.12.6.3.1. Sardine in GSA 17-18. Total biomass (tons) estimated by the acoustic surveys.

Data exploration of the tuning data are showed in the figures below (Figs. 4.2.12.6.3.2 a,b,c). Even though the data showed a general lack of internal consistencies, they were used to tune the assessment.

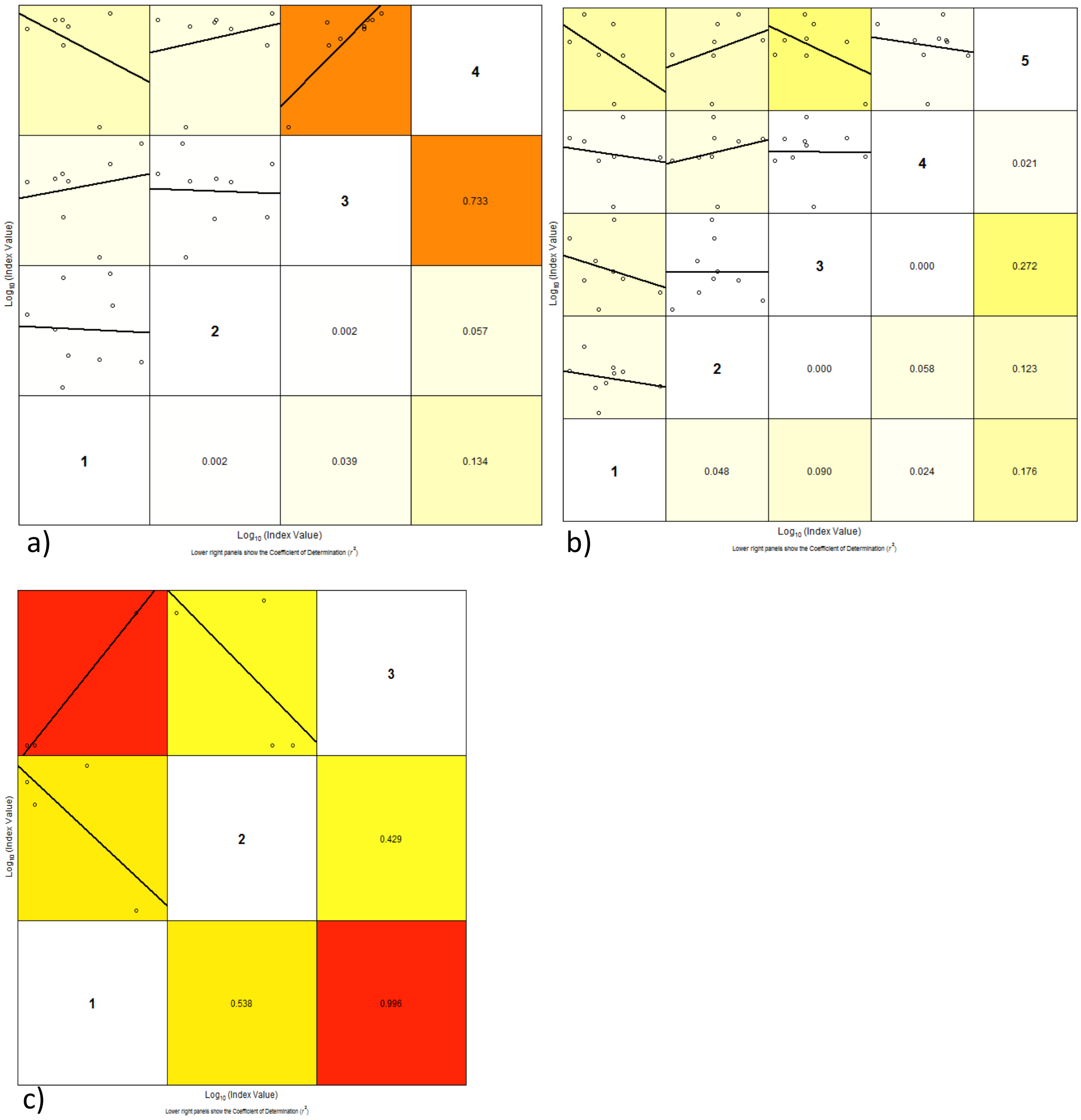

Figure 4.2.12.6.3.2. Sardine in GSA 17-18. Internal consistency between ages for respectively: a) numbers at age from Western acoustic GSA 17; b) numbers at age from Eastern acoustic GSA 17; c) numbers at age from Western acoustic GSA 18.

The trend in numbers at age for the three surveys is shown in figure 4.2.12.6.3.3 a,b,c.

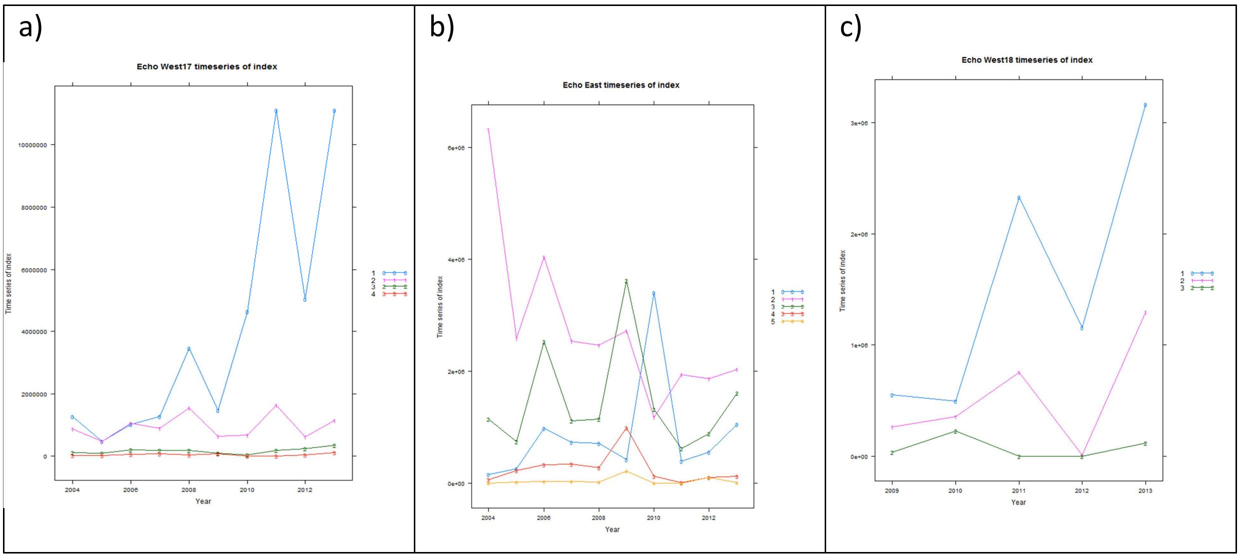

Figure 4.2.12.6.3.3. Sardine in GSA 17-18. Trend in numbers at age for respectively: a) the Western acoustic GSA17; b) the Eastern acoustic GSA17; c) the Western acoustic GSA18.

4.2.12.6.4 Trends in abundance by length or age

No specific analyses were conducted during EWG-14-09.

4.2.12.6.5 Trends in growth

No specific analyses were conducted during EWG-14-09.

4.2.12.6.6 Trends in maturity

No specific analyses were conducted during EWG-14-09

4.2.12.7 Assessment of historic stock parameters

State-space Assessment Model (SAM) has been performed on the data from 1975 to 2013. Acoustic surveys were used to tune the assessment of sardine in GSA 17-18.

Age 0 was not included in the model: the high natural mortality, in fact, drives the biomass to really high and quite unrealistic values. Since age 0 is not largely represented in the catches, the EWG 14-09 decided not to include it in the assessment.

4.2.12.7.1 Methods:SAM

4.2.12.7.2Justification

The stock of sardine was asssessed using the State-space Assessment Model (SAM) (Nielsen *et al.*, 2012) in FLR environment with data from 1975 to 2013. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package "FLSAM". The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. Three tuning indices (acoustic survey covering the west and acoustic survey covering the east side in GSA 17 from 2004 to 2013, as well as acoustic survey covering the west part of the GSA 18 from 2009 to 2013) were used in the assessment. All assessments are performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

4.2.12.7.3 Input parameters

Input data types and characteristics are given in Table 4.2.12.7.3.1.

Table 4.2.12.7.3.1. Sardine in GSA 17-18. Input data for SAM assessment.

	Age1	Age2	Age3	Age4	Age5+
1975	196872	184785	139141	113154	159741
1976	378135	293341	251215	181859	101044
1977	424459	305903	301451	228645	130855
1978	268163	209230	248257	208810	165745
1979	247252	225238	215768	169741	130221
1980	225287	259986	282353	222613	159290
1981	942739	583179	466272	356063	247239
1982	877161	550428	387793	291664	219919
1983	886733	564128	350285	259091	213519
1984	1000396	652717	355584	254555	229811
1985	597877	652814	351977	218205	131033
1986	280317	448247	513737	409118	315919
1987	621585	348854	486209	375385	226129
1988	322981	555883	273353	356686	426510
1989	383448	889647	378067	223722	221932
1990	214298	699639	435284	233827	171549
1991	166053	484875	450003	270124	136672
1992	90073	319053	388391	227951	127387
1993	214719	292914	344197	252214	167150
1994	178301	277329	283381	198305	149128
1995	79889	183735	250511	196022	149386
1996	148904	182520	234733	230322	218455
1997	156773	198792	227357	197966	173467
1998	180028	192649	209486	179713	160552
1999	180291	134918	138516	131763	145616
2000	248139	201293	100614	52775	79802
2001	214205	316638	97164	25059	25988
2002	204389	421926	122482	21111	16000
2003	206112	430510	138136	14210	5540
2004	234778	424768	181783	12314	2732

2005	87071	273196	195903	62205	13875
2006	64602	182346	227564	80921	22278
2007	71882	224388	206765	78864	46043
2008	192104	255802	179815	116865	49325
2009	117099	365418	314505	144474	95532
2010	234844	488484	380977	33559	15939
2011	623829	1103487	448641	54130	9773
2012	583898	952364	538287	132231	59248
2013	1449629	1181459	179342	17296	6791

Mean weight at age in the catches is shown in Figure 4.2.12.5.4.5

All the configuration setting used in the SAM model this year are presented in the Table 4.2.12.7.3.2.

Table 4.2.12.7.3.2. Sardine in GSA 17-18.. Configuration settings for SAM model.

name	**Final**	**Assessment**					
range	**min**	**max**	**plusgroup**	**minyear**	**maxyear**	**minfbar**	**maxfbar**
	1	5	5	1975	2013	1	3
fleets	Three Acoustic Surveys: western GSA 17 (2004 – 2012; Fleet1), eastern GSA 17 (2004 – 2012, Fleet2), western GSA18 (2009-2013, Fleet3)						
plus.group	TRUE						
age		1	2	3	4	5	
logN.vars		0	1	1	1	1	
catchabilities	Fleet1	1	2	2	3		
catchabilities	Fleet2	1	2	2	3	4	
catchabilities	Fleet3	1	2	2			
f.vars	catch	1	1	1	2	2	
obs.vars	Fleet1	1	1	1	2		
obs.vars	Fleet2	1	1	1	2	3	
obs.vars	Fleet3	1	1	1			
obs.vars	catch	1	2	2	3	3	

4.2.12.7.4 Results

SAM outputs are listed in table 4.2.12.7.4.1

Table 4.2.12.7.4.1. Sardine in GSA 17-18. Main results of the SAM assessment model.

Year	Recruits Age 0 (Thousands) Mean	Recruits Age 0 (Thousands) Low	Recruits Age 0 (Thousands) High	Total biomass (tonnes) Mean	Total biomass (tonnes) Low	Total biomass (tonnes) High	Spawing biomass (tonnes) Mean	Spawing biomass (tonnes) Low	Spawing biomass (tonnes) High	Landings (tonnes) Mean
1975	11816412	9095773	15350822	563544	454908	698122	328404	263145	409847	35348
1976	11792803	9204987	15108137	571489	464834	702615	335373	270383	415985	41274
1977	11319076	8823793	14520000	571489	466358	700319	334369	270134	413878	47715
1978	12397433	9726758	15801395	580126	474921	708635	340442	276229	419582	44936
1979	13964096	11092920	17578417	689002	568662	834809	404335	331308	493459	47858
1980	15525587	12357790	19505417	781523	648509	941819	457714	377431	555075	54557
1981	15603409	12404894	19626640	708567	589798	851252	406362	334299	493959	73204
1982	16768287	13341964	21074518	751630	623316	906360	429768	352424	524086	75358
1983	18310771	14571265	23009966	831511	688517	1004203	475918	390107	580603	79380
1984	20480832	16313488	25712741	937526	776145	1132462	537132	440656	654731	84542
1985	16751527	13384652	20965333	922645	768660	1107478	536059	442553	649322	80822
1986	12127668	9586239	15342860	722159	603888	863592	422101	349031	510469	73865
1987	14048132	11291469	17477799	609260	511687	725439	349759	290257	421459	66105
1988	15697311	12724064	19365320	633490	533379	752391	361494	301312	433696	60114
1989	14916820	12083352	18414718	647582	546561	767274	367692	306662	440868	67037
1990	12864730	10358338	15977589	605010	509611	718268	347319	289308	416963	60536
1991	11128278	8894926	13922383	540906	454085	644326	312075	259137	375828	53477
1992	10386319	8258540	13062311	517622	432424	619605	301040	249053	363880	47146
1993	10129880	8002864	12822218	470241	390722	565942	272938	224567	331728	43217
1994	8461187	6681017	10715686	435827	361386	525601	253977	208486	309394	39775
1995	7109909	5683567	8894204	378133	315794	452777	221682	183251	268173	34648
1996	5763180	4682478	7093305	300139	254232	354334	173685	145419	207446	33390
1997	3805660	3147420	4601562	226613	195474	262713	128541	109279	151198	32663
1998	2533215	2116677	3031724	151146	132094	172946	82785	71073	96426	28624
1999	2421748	2079148	2820800	115613	102709	130137	61821	54144	70587	21504
2000	2946121	2576292	3369040	119850	108053	132936	63196	56464	70732	20300
2001	3779113	3296269	4332686	137310	123596	152547	72258	64563	80870	21418
2002	4871926	4189138	5666003	165215	146810	185926	87553	77129	99386	23435
2003	5609656	4751292	6623091	181498	159331	206750	99012	86187	113746	22203
2004	5482107	4584561	6555370	190422	166151	218239	105662	91247	122354	23718
2005	4867057	4025668	5884301	190613	164740	220550	108662	93090	126839	19630
2006	4408301	3691544	5264226	186652	162501	214392	106938	92263	123946	19287
2007	4785016	4114682	5564556	180052	159962	202664	102028	89876	115822	20050
2008	6168708	5319077	7154054	219696	196050	246194	123624	109775	139220	22561
2009	6983076	6088962	8008482	248202	223707	275381	136899	122559	152917	29115
2010	9801049	8519597	11275248	291851	262580	324386	159851	143034	178646	34544
2011	7992387	6503347	9822364	271034	235991	311281	139804	119527	163523	53691
2012	10069282	7427430	13650812	292728	230634	371541	147709	111734	195267	57354
2013	12698571	7825664	20605752	336045	224579	502834	174905	111012	275571	56500

Year	Landings (tonnes) Low	Landings (tonnes) High	Yield / SSB (ratio) Mean	Yield / SSB (ratio) Low	Yield / SSB (ratio) High	Mean F ages 1-3 Mean	Mean F ages 1-3 Low	Mean F ages 1-3 High	Mean F ages 1-2	SoP (%)
1975	27486	45460	0.1076	0.1044	0.1109	0.1124	0.0823	0.1535	0.0610	1.00
1976	35455	48050	0.1231	0.1311	0.1155	0.1428	0.1092	0.1868	0.0796	1.00
1977	41142	55338	0.1427	0.1523	0.1337	0.1522	0.1167	0.1986	0.0844	1.00
1978	38454	52511	0.1320	0.1392	0.1252	0.1234	0.0953	0.1598	0.0643	1.01
1979	40607	56404	0.1184	0.1226	0.1143	0.1110	0.0865	0.1425	0.0610	1.00
1980	46822	63569	0.1192	0.1241	0.1145	0.1256	0.0984	0.1603	0.0642	1.00
1981	63828	83956	0.1801	0.1909	0.1700	0.2021	0.1600	0.2554	0.1201	1.00
1982	64351	88247	0.1753	0.1826	0.1684	0.1846	0.1452	0.2346	0.1250	0.99
1983	67283	93651	0.1668	0.1725	0.1613	0.1760	0.1382	0.2241	0.1212	1.00
1984	71752	99612	0.1574	0.1628	0.1521	0.1697	0.1342	0.2146	0.1233	0.99
1985	69845	93523	0.1508	0.1578	0.1440	0.1516	0.1201	0.1915	0.1069	1.00
1986	64951	84003	0.1750	0.1861	0.1646	0.1600	0.1261	0.2030	0.0903	1.00
1987	57454	76059	0.1890	0.1979	0.1805	0.1781	0.1404	0.2259	0.0969	1.00
1988	52061	69412	0.1663	0.1728	0.1600	0.1715	0.1362	0.2160	0.1182	1.01
1989	60021	74874	0.1823	0.1957	0.1698	0.2206	0.1757	0.2770	0.1575	1.01
1990	54463	67287	0.1743	0.1883	0.1614	0.2150	0.1694	0.2729	0.1298	1.00
1991	47670	59990	0.1714	0.1840	0.1596	0.2024	0.1589	0.2578	0.1029	1.01
1992	41464	53606	0.1566	0.1665	0.1473	0.1789	0.1399	0.2287	0.0793	1.01
1993	37998	49153	0.1583	0.1692	0.1482	0.1750	0.1370	0.2235	0.0796	1.00
1994	34905	45325	0.1566	0.1674	0.1465	0.1562	0.1225	0.1992	0.0789	1.00
1995	30149	39818	0.1563	0.1645	0.1485	0.1382	0.1076	0.1776	0.0666	1.01
1996	28914	38558	0.1922	0.1988	0.1859	0.1584	0.1244	0.2016	0.0819	1.00
1997	28328	37661	0.2541	0.2592	0.2491	0.1992	0.1592	0.2493	0.1158	1.01
1998	24882	32928	0.3458	0.3501	0.3415	0.2708	0.2198	0.3337	0.1776	1.01
1999	18425	25098	0.3478	0.3403	0.3556	0.3221	0.2611	0.3973	0.2044	1.01
2000	17441	23628	0.3212	0.3089	0.3341	0.4403	0.3637	0.5331	0.3060	1.00
2001	18727	24496	0.2964	0.2901	0.3029	0.5906	0.4920	0.7089	0.3903	1.01
2002	20734	26489	0.2677	0.2688	0.2665	0.7270	0.5978	0.8840	0.3849	1.00
2003	19752	24959	0.2242	0.2292	0.2194	0.5502	0.4517	0.6702	0.2811	0.99
2004	21518	26144	0.2245	0.2358	0.2137	0.4123	0.3389	0.5015	0.2284	1.00
2005	17905	21521	0.1806	0.1923	0.1697	0.3038	0.2447	0.3771	0.1445	1.00
2006	17532	21219	0.1804	0.1900	0.1712	0.2771	0.2216	0.3467	0.1068	0.99
2007	18160	22137	0.1965	0.2021	0.1911	0.2800	0.2270	0.3454	0.1419	1.01
2008	20213	25183	0.1825	0.1841	0.1809	0.3110	0.2545	0.3801	0.1536	1.00
2009	26523	31959	0.2127	0.2164	0.2090	0.5390	0.4388	0.6620	0.1713	1.01
2010	31043	38441	0.2161	0.2170	0.2152	0.5459	0.4497	0.6626	0.2111	1.00
2011	48576	59345	0.3840	0.4064	0.3629	0.7227	0.6124	0.8529	0.3597	1.09
2012	50638	64962	0.3883	0.4532	0.3327	0.8693	0.6642	1.1376	0.4637	1.09
2013	46105	69240	0.3230	0.4153	0.2513	0.5339	0.3467	0.8223	0.4502	1.01

Table 4.2.12.7.4.2. and 4.2.12.7.4.3. give respectively the fishing mortality at age by year and the stock numbers at age by year (in thousand).

Table 4.2.12.7.4.2. Sardine in GSA 17-18. F at age estimated from 1975 to 2013

	year							
age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
1	0.036857	0.04437	0.047109	0.04066	0.037783	0.0413	0.064758	0.073881
2	0.085111	0.114842	0.121651	0.087975	0.084289	0.087056	0.17545	0.176206
3	0.215197	0.269281	0.287912	0.241593	0.211042	0.248503	0.366154	0.303644
4	0.614959	0.616504	0.617127	0.617103	0.615457	0.616455	0.621114	0.623273
5	4.475867	4.476314	4.475867	4.473629	4.470052	4.470499	4.473629	4.472735
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
1	0.074185	0.069148	0.059648	0.051855	0.051975	0.041073	0.036964	0.030288
2	0.168116	0.177533	0.154077	0.128696	0.141919	0.195421	0.277954	0.229306
3	0.285647	0.262422	0.241207	0.299452	0.340309	0.278065	0.347045	0.385428
4	0.625027	0.628588	0.628839	0.636271	0.640735	0.649865	0.657566	0.666403
5	4.470052	4.467371	4.461567	4.463352	4.460229	4.460229	4.453543	4.447757
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
1	0.026252	0.02349	0.028898	0.031398	0.031619	0.045081	0.067185	0.097481
2	0.17964	0.135051	0.13025	0.1264	0.101571	0.118778	0.164507	0.257741
3	0.401387	0.377989	0.365752	0.310864	0.281506	0.311206	0.365898	0.457234
4	0.6737	0.67705	0.68154	0.684696	0.689513	0.700732	0.714166	0.73125
5	4.440203	4.434878	4.433991	4.432661	4.432217	4.432661	4.427345	4.420267
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	0.112737	0.112602	0.092968	0.074489	0.062537	0.053864	0.038592	0.032732
2	0.296058	0.499329	0.687661	0.695232	0.499749	0.402879	0.250499	0.18083
3	0.557513	0.708979	0.991061	1.411228	1.088387	0.780024	0.622271	0.617893
4	0.752774	0.775723	0.797575	0.822563	0.837679	0.836181	0.848767	0.858868
5	4.410553	4.395143	4.374534	4.356635	4.335773	4.317601	4.278489	4.262688
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
1	0.033253	0.040228	0.041324	0.053928	0.090727	0.107464	0.133761	
2	0.250549	0.267028	0.301315	0.368192	0.628713	0.820001	0.766684	
3	0.556204	0.625828	1.27424	1.215566	1.448632	1.68043	0.701384	
4	0.874205	0.896381	0.934587	0.953717	0.961742	0.985461	0.971263	
5	4.263967	4.268233	4.27464	4.302086	4.324515	4.29349	4.279773	

Table 4.2.12.7.4.3. Sardine in GSA 17-18. Stock numbers at age from 1975 to 2013.

	year					
age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
1	11816412	11792803	11319076	12397433	13964096	15525587
2	3239728	3809468	3749001	3555478	3964935	4497355
3	958380.3	1401425	1584850	1538010	1516628	1708284
4	337054.5	417901.1	577232.3	635393.6	644996.4	662648.5
5	179692.1	105450.8	129832.4	178795.9	196221.6	200185.6
	1981	**1982**	**1983**	**1984**	**1985**	**1986**
1	15603409	16768287	18310771	20480832	16751527	12127668
2	5025322	4813813	5162854	5643415	6446191	5288261
3	1966961	1963031	1867292	2039061	2193480	2610363
4	721436.8	735275.1	779182.1	748629.9	843234.2	928197.7
5	206695.1	223239.4	227066.9	240145.4	228205.1	259886.4
	1987	**1988**	**1989**	**1990**	**1991**	**1992**
1	14048132	15697311	14916820	12864730	11128278	10386319
2	3760265	4421546	5070754	4799393	4159893	3598401
3	2200071	1507556	1696368	1790490	1785127	1624970
4	1047587	843234.2	614153.4	642421.6	652783	641779.5
5	282095.2	319336.3	253723.4	183689.1	189094.1	190422.4
	1993	**1994**	**1995**	**1996**	**1997**	**1998**
1	10129880	8461187	7109909	5763180	3805660	2533216
2	3395630	3291981	2722334	2315185	1854267	1183516
3	1474751	1401425	1355933	1158921	974812.1	744896.1
4	599589.2	550179.6	555153.5	552937.4	459548.6	367324.2
5	187587.4	174381.4	159851.4	161296.6	158419.2	130352.8
	1999	**2000**	**2001**	**2002**	**2003**	**2004**
1	2421748	2946121	3779113	4871927	5609656	5482107
2	747881.6	709985.6	869783.8	1145097	1515112	1769133
3	424641.3	258073.6	198988	202602.3	265667.3	432354
4	255505.7	130222.5	68118.2	39537.3	26317.8	47954.1
5	102744.4	69772.8	34682.8	17790.1	9979.6	6491.8
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
1	4867057	4408301	4785016	6168708	6983076	9801049
2	1737573	1576945	1415509	1536473	1970898	2228858
3	552384.7	638578.6	629071.4	510425.5	546888.4	684196.2
4	107151.6	160652.7	185720.8	197600	147561.5	81226.8
5	11988.5	26291.5	39300.8	44756.9	47145.8	33123.6
	2011	**2012**	**2013**			
1	7992387	10069282	12698571			

2	3188305	2343134	3008644			
3	727959	802911.7	473070.6			
4	110194.3	92226.2	79538.8			
5	17951	24636.9	19553.3			

The average fishing mortality for ages 1-3 (presented in figure 4.2.12.7.4.1., middle) starts increasing in 1995, with a first peak of 0.73 in 2002 and a second one in 2012 equal to 0.87. The estimate for 2013 is equal to 0.533.

The mid year spawning stock biomass (figure 4.2.12.7.4.1., top) fluctuates from the highest values in 1984 (about 537,000 tons) to a minimum in 1999 of 61,821 tons. After that the stock is constantly increasing: in 2013 the stock of sardine reaches the highest value registered in the last decade (174,905 tons).

The recruitment (age 1 – figure 4.2.12.7.4.1., bottom) fluctuates around a minimum value of 2,420 millions individuals in 1999, to a maximum value of 20,480 millions individuals in 1984. From 1999 the estimated recruitment is constantly increasing: the value for 2013 is equal to 12,700 millions individuals.

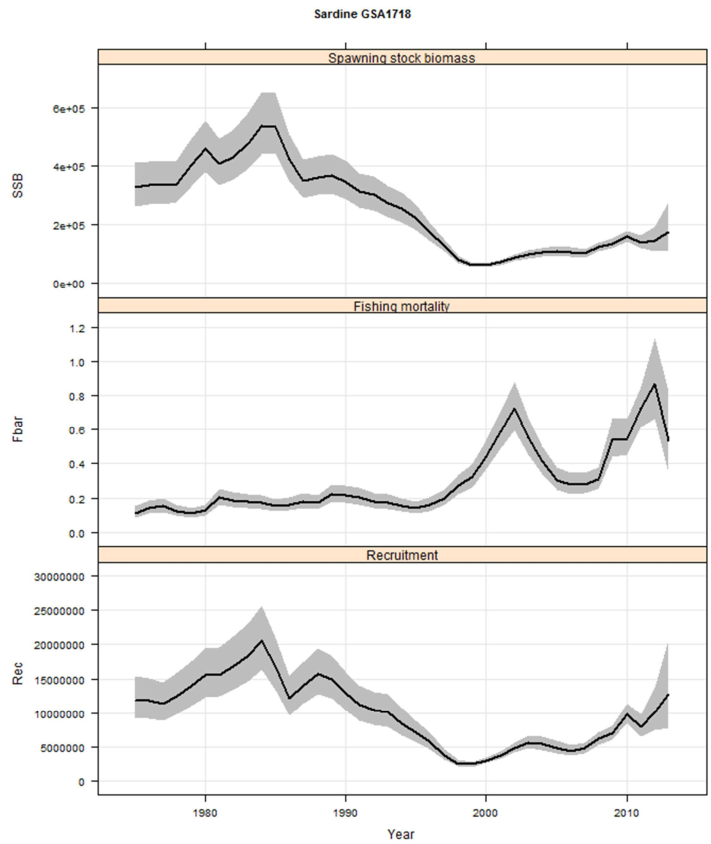

Figure 4.2.12.7.4.1. Sardine in GSA 17-18. Mid year Spawning Stock Biomass (SSB) in tons (on top). F(age 1-3) (middle); recruitment (in thousands individuals) (bottom); 95% confidence intervals are shown.

Selectivity by age classes is plotted in the figure 4.2.12.7.4.2. The trend in selectivity is really strange, with a huge and unrealistic selectivity for the last age class (age 5). This pattern may be due to some inconsistencies in the oldest age classes in the input data, therefore it cannot be improved in the model settings. If age 5 is removed from the plots, it is possible to appreciate an improvement in the selectivity pattern in the more recent pentads, with a selectivity that increase up to age 3 and then decreases again in age 4 (Figure 4.2.12.7.4.2., right). This issue should, nevertheless, be investigated.

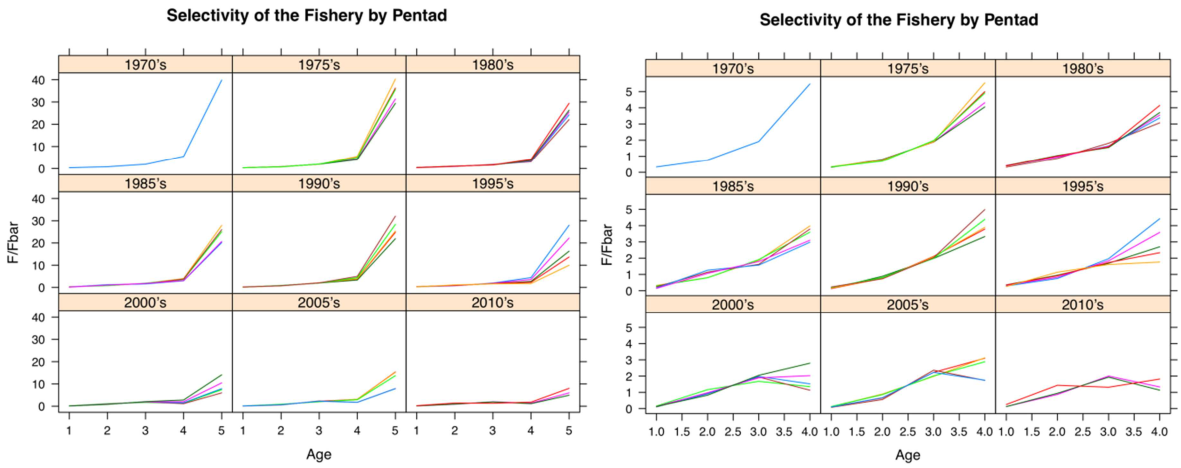

Figure 4.2.12.7.4.2. Sardine in GSA 17-18. Selectivity at age by pentads as resulting from the SAM model with (on the left) and without (to the right) age 5.

Catch residuals did not show any particular trend. On the other hand, all of the survey data showed some patterns in the residuals for all ages and years. In the figures below only age 1 is shown as example of the perfect fitting in the catches, and of the overall bad fitting of the tuning indices (figure 4.2.12.7.4.3. a, b, c, d).

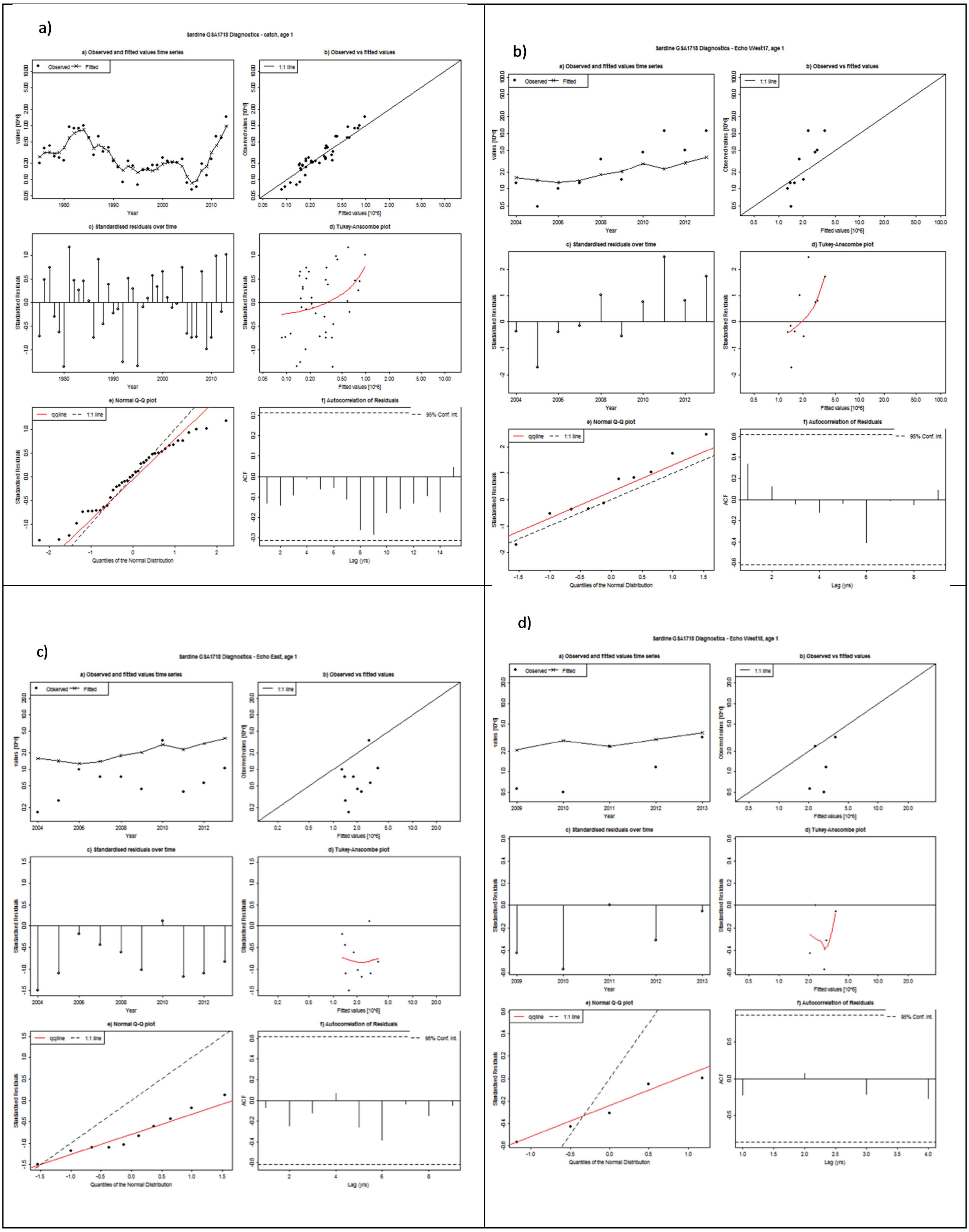

Figure 4.2.12.7.4.3. Sardine in GSA 17-18. Diagnostic in catch and survey age structure residuals (age 1) for respectively: a) total catches age 1; b) western echosurvey GSA 17 age 1; c) Eastern echosurvey GSA 17 age 1; d) western echosurvey GSA 18 age 1.

Also, observation variances by input data (fig. 4.2.12.7.4.4.) showed that model is overfitting the catch data and among the surveys is practically using only the Echo West GSA 17 as the variability in the other input data is high.

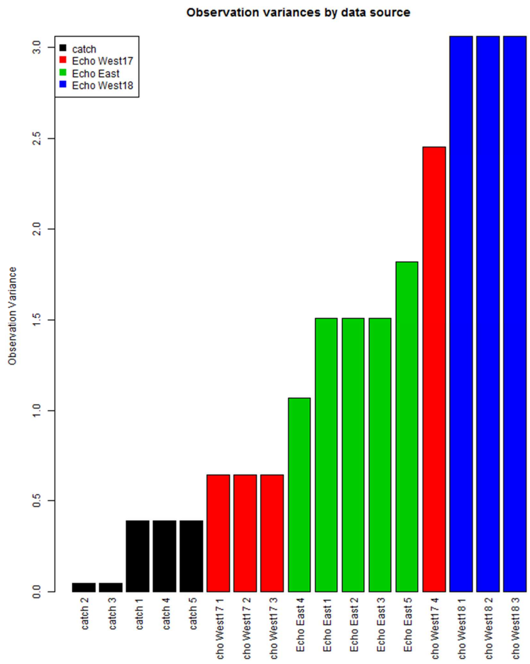

Figure 4.2.12.7.4.4. Sardine in GSA 17-18. Plot of the observation variances by input data.

4.2.12.8 Long term prediction

Medium term simulations performed are reported in section 4.11.4

4.2.12.9 Data quality

An accurate analysis of the available data for sardine stock in GSA 17 and GSA 18 detected strong inconsistencies, which are listed below:

- Age structure problem in catch matrix and survey numbers at age (Figure 4.2.12.9.1.). Looking at the row data of length frequency distribution from the western catch and the eastern catch, it is evident a clear difference in the otolith reading, which compromise the structure of catch data. For example, sardine of the same lengths have different ages between western readers and eastern readers, this difference being more noticeable for ages 0 and 1.

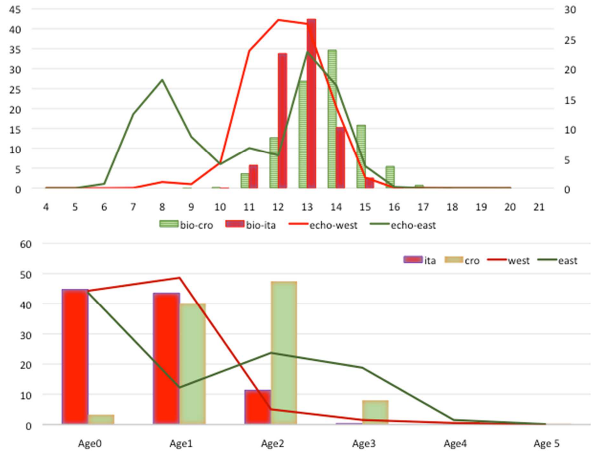

Figure 4.2.12.9.1. Sardine in GSA 17-18. Length frequency distribution (on top) and age structure (at the bottom) in catch matrix and survey numbers at age for 2013 from western and eastern data.

- Internal inconsistency of acoustic surveys: the age structure of the three acoustic surveys used is highly inconsistent and it is not able to follow the cohorts in time. For example, for the present assessment in which the three surveys have been used independently from each other, it was necessary to aggregate some age classes, due to gaps in the age structure. This internal inconsistency implies a high variance in the surveys data, which therefore are assigned a low weight in the model with a consequently overfitting of the catch data.
- Total landings before 2000 have been split into Length Frequency Distribution using biological data from the Italian side alone. The entire time series before 2000 has been disaggregated into numbers at age using biological data from the western Adriatic area, without taking into account the different length structure in the catches between the western and the eastern catches. An attempt to apply a common ALK to the whole time series of raised length frequency distribution produced a completely different catch structure, implying also difference in the total landings.

– <u>Fluctuations in the weight at age in the most recent years</u> (Figure 4.2.12.9.2.). The weight at age for the 2011 and 2012 in particular for ages 1, 2 and 3 had to be re-estimated using average between 2010 and 2012.

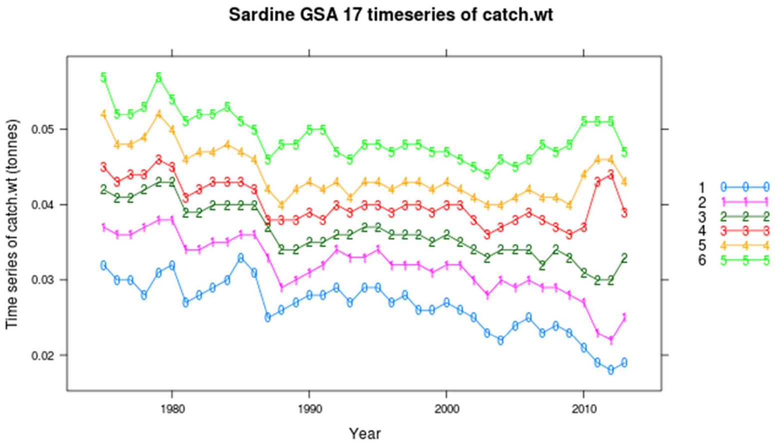

Figure 4.2.12.9.2. Sardine in GSA 17-18. Mean weight at age (kg) of the catch at age from 1975 to 2013.

– <u>No information on length or age structure of GSA 18:</u> no biological information are available before 2004 for GSA 18, therefore all the data used for the present assessment had to be reconstructed.

Suggested Roadmap:

EWG 14-09 suggests that:

– The countries involved try to find way to overcome differences in the age reading and agree on a common ALK.
– Length Frequency Distribution from eastern catches should be applied to the eastern landings before 2000, and the new structure in the catch should be compared with the old one to evaluate the changes.
– A review of the age-structure of acoustic should be considered, to improve the internal consistency of the survey.
– From the previous steps, changes in the weight at age matrix will follow. The reliability of the new weight at age matrix should be evaluated; if not satisfactory, the reasons behind the high fluctuations observed in the weight at age matrix should be identified.

4.2.12.10 Scientific advice

The stock spawning biomass is estimate to be below B_{lim} and F is above F_{MSY}.

4.2.12.11 Short term considerations

4.2.12.11.1 State of the spawning stock size

Results of the Stock-space Assessment Model (SAM) indicated a constant increase in total biomass starting in the late nineties, with almost stable values in the last 5 years, with a value of 336,045 tons in 2013. The same trend is reflected in the spawning stock biomass mid-year estimate, that is estimated at 174,905 tons in 2013.

Biomass reference points were estimated from the SAM results using the approach of a typical medium term projection, but including uncertainty in the choice of the stock recruitment model. The biomass of sardine in 2013 (mid year SSB = 174,905 t) is above the B_{lim} reference point estimated through the medium term projection (B_{lim} no age 0 = 153,507 t).

4.2.12.11.2 State of recruitment

The recruitment level (corresponding to age 1 in the model) is constantly increasing since the drop in recruitment occurred from 1985 to 1999. In 2013 recruitment reaches the highest value after the peak in 1984, with 12,698,571 thousands specimens.

4.2.12.11.3 State of exploitation

Based on SAM results, the F_{bar} (1-3) shows the highest value in 2002 equal to 0.598 and then decrease; the estimated value for 2013 is 0.533. Thus, the current F (0.53) is larger than F_{MSY} (0.23), which indicates that sardine in GSA 17-18 is exploited unsustainably.

4.2.12.12 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed FMSY level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.13 STOCK ASSESSMENT OF HAKE IN GSA 17

4.2.13.1 Stock Identification

The stock of European hake was assumed in the boundaries of the whole GSA 17 (Fig. 4.2.13.1.1.).

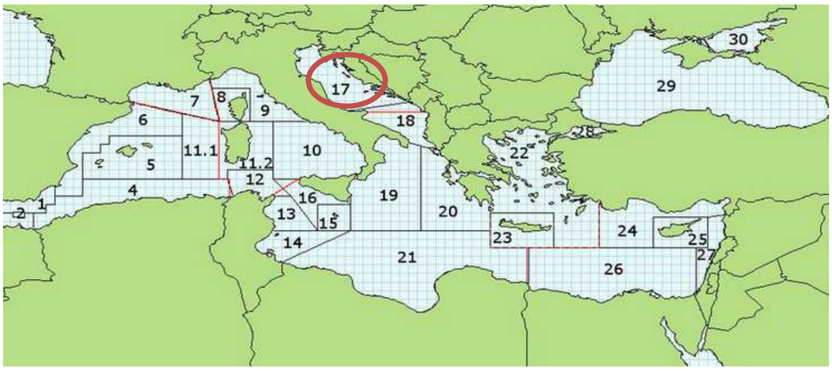

Fig. 4.2.13.1.1. Geographical location of GSA 17.

Spawning of hake occurs throughout the year with two peaks in winter and summer. Earliest spawning occurs in winter in deeper waters, up to 200 m, in the Pomo/Jabuka Pit (where the greatest depths in GSA 17 are observed). In the summer period, spawning occurs in shallower waters. Nursery areas are located close to the Pomo/Jabuka Pit (Vrgoc *et al.*, 2004). The group decided to wait for the final results of STOCKMED ("Stock units: Identification of distinct biological units (stock units) for different fish and shellfish species and among different GFCM-GSA") project (MAREA PROJECT - MARE/2009/05-Lot 1 Specific contract n.7) to evaluate the possibility to perform a joint assessment of GSA 17 and 18.

4.2.13.2 Growth

According to Jardas (1996), European hake can grow to 130 cm of total length. However, its usual length in trawl catches is from 10 to 60 cm. This is a long-lived species, it can live more than 20 years. In the Adriatic, however, the exploited stock is mainly composed in number of 0+, 1+ and 2+ year-old individuals. On the basis of the vertebral counts of European hake from the northern and central Adriatic, Piccinetti and Piccinetti Manfrin (1971b) found that all specimens analysed belonged to the same population. Similarly, the Adriatic population has the same number of vertebrae as the European hake from the rest of the Mediterranean (Maurin, 1965).

Hake in GSA 17. Total Length (TL, cm) and age (year) data from bibliography:

Author	Sex	Age (yr)							
		1	2	3	4	5	6	7	8
Ghirardelli, 1959b	M+F	18.8	23.0	28.8	38.0	-	-	-	-
Županović, 1968	M+F	9	19	28	35	40	44	49	57
Flamigni, 1983	M+F (May)	14.3	21.3	29.0	35.0	-	-	-	-
	M+F (Nov.)	19.0	26.2	33.3	39.0	-	-	-	-

Hake in GSA 17. Parameters of the Von Bertalanffy Growth Function (VBGF):

Author	Sex	L_∞(cm)	K(yr^{-1})	t_0(yr)	Φ’
Flamigni, 1983	M+F	85	0.12	-	6.77
Alegria Hernandez and Jukić, 1990	M+F	92.83	0.097	-0.629	6.73
Bolje, 1992	M+F	75	0.12	-	6.52
Vrgoč, 1995 (“Hvar”)	M+F	83.27	0.125	-0.73	6.76
Ungaro *et al.,* 1993	M+F	75.68	0.153	0.14	6.78
	F	82.63	0.126	-0.312	6.76
Marano, 1996	M	57	0.17	-0.83	6.31
	F	67.5	0.159	-0.436	6.59
	M+F	67.5	0.144	-0.807	6.49
	M+F (Bhatt)	81	0.25	-	7.40
Marano *et al.*, 1998b Marano *et al.*, 1998c	M	72	0.15	0.005	6.66
	F	84	0.13	0.102	6.82
	M+F	84	0.12	-0.14	6.74
	M+F(Bhatt)	62.2	0.23	-	6.79
	M+F (Surf.)	68	0.25	-	7.05
Vrgoč, 2000	M+F	77.95	0.130	-	6.67
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	68.19	0.157	-	6.59
EC XIV/298/96-EN, Adriatic Sea	M+F	85.0	0.12	-	6.77
Fast growth	M+F	104.0	0.2	-0.01	6.73

Females attain larger size than males, that grow more slowly after maturation at the age of three or four years. Consequently, the proportion of males in the population is higher in lower length classes and proportion of females is higher at greater lengths. In the central and northern Adriatic, females already start dominating the population at lengths of about 30 to 33 cm. In trawl catches over 38 to 40 cm, almost all the specimens are females (Vrgoč, 2000).

4.2.13.3 Maturity

In the Adriatic, European hake spawns throughout the year, but with different intensities. The spawning peaks are in the summer and winter periods (Karlovac, 1965; Županović, 1968; Županović and Jardas, 1986, Županović and Jardas, 1989; Jukić and Piccinetti, 1981; Ungaro *et al.,* 1993). Hake are partial spawners. Females spawn usually four or five times without ovarian rests. In females in the pre-spawning stage, fish 70 cm long can contain more than 400,000 oocytes (Sarano, 1986). The earliest spawning in the Pomo/Jabuka Pit occurs in winter in deeper water, (up to 200 m). As the season progresses into the spring-summer period, spawning occurs in more shallow water. The recruitment of young individuals into the breeding stock has two different maxima. The first one is in the spring and the second one in the autumn.

In the Pomo/Jabuka Pit, both of these maxima can be linked to hake's more intense summer and winter spawning period in the central Adriatic (Županović and Jardas, 1989). The recruitment peaks are in the spring and autumn (Karlovac, 1965). Recruitment does not seem to be related to the parental stock size (Alegria Hernandez and Jukić, 1992). Nursery

areas are located close to the Pomo/Jabuka Pit, between 150 and 200 m, on the upper part of the slope, and off the Gargano Cape (Županović, 1968; Jukić and Arneri, 1984; Županović and Jardas, 1986, Županović and Jardas, 1989; Frattini and Paolini, 1995; Frattini and Casali, 1998; Lembo et al., 2000). Karlovac (1965) recorded young hake larvae from October to June, the highest numbers were recorded in January and February. Larvae and postlarvae were mainly distributed between 40 and 200 m; the highest number of individuals was caught mainly between 50 and 100 m.
The areas of persistency identified in MEDISEH project (Giannoulaki et al. 2013) for the recruits of European hake in GSA 17 are comprised between 150 and 200 m and located in three areas: the former is southwards the Pomo/Jabuka Pit and parallel to the Italian coast (25 nm from Abruzzo – Apulia Regions; R1), the second is the widest one and is located just eastwards the Pomo/Jabuka Pit area and close to the Croatian Islands (R2) and the third is near the southern limit of GSA17 (R3, Fig. 4.2.13.3.1).
The four areas of persistency identified in MEDISEH project (Giannoulaki et al. 2013) for the spawners of European Hake in GSA 17 are located in the eastern side of the basins and comprised between 50-200 m of depth. S1 is located in the Kvarner Gulf, S2 is located northwards the Pomo/Jabuka Pit, S3 is located between the Islands of Brac and Hvar, S4 is in the Croatian side of the southern limit of GSA 17 (Fig. 4.2.13.3.1).

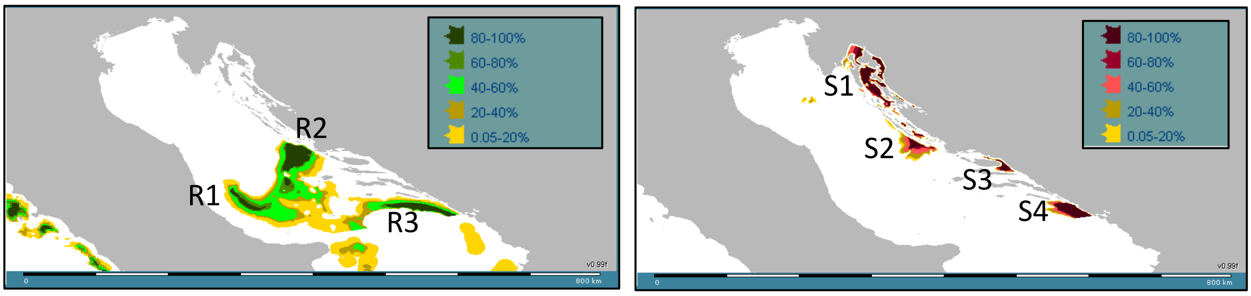

Fig. 4.2.13.3.1. Hake in GSA 17. Position of persistent nursery (left) and persistent areas of potential spawners (right) (MEDISEH project).

Different data about the size at first sexual maturity of hake in GSA 17, given by different authors, are shown in the table below.

Author	Sex	(L_m, cm)
Zei, 1949	M	22.30
Županović, 1968	M	20.28
	F	26-33
Županović and Jardas, 1986	M	20-28
	F	23-33
Ungaro *et al.*, 1993	M+F	25-30
Cetinić *et al.*, 1999	M+F (Velebit Channel)	24

In the following analyses maturity at age for the sex combined from data available from GSA 17 were used.

4.2.13.4 Fisheries

4.2.13.4.1 General description of Fisheries

The fisheries for hake are one of the most important in the GSA 17. Fishing grounds mostly correspond to the distribution of the stock (SEC (2002) 1374). In GSA 17 hake is a target species for the Italian and Croatian otter trawlers as well as Croatian long liners, but also in smaller quantity in the gill-net Croatian fisheries.

4.2.13.4.2 Management regulations applicable in 2014-2015

Italy,Slovenia and Croatia:

- Fishing closure for trawling: 30-60 days in summer.
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for hake.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

Moreover, Croatia maintained regulation measures applied before 2013:

- Bottom trawl fisheries is closed one NM from the coast and island in inner sea, 2 NM around island on the open sea, and 3 NM about several island in the central Adriatic. Bottom trawl fisheries is closed also in the majority of channel area and bays.
- About 1/3 of the territorial waters is closed for bottom trawl fisheries over whole year and additionally 10% is closed from 100-300 days per years.

4.2.13.4.3 Catches

4.2.13.4.4 Landings

On the basis of DCR data for Italy through DCR from 2006 to 2013 (Tab. 4.2.13.4.4.1), from Slovenia from 2005 to 2013 and from Croatia (2013) landings are due mainly to bottom otter trawlers.

However, on the basis of STECF 13-05 report, the species is target also for Croatian long liners and for Croatian gill-net.

Tab. 4.2.13.4.4.1. Hake in GSA 17. Landings (tonnes) by fishing technique, 2006-2013 from DCF data.

	HRV	ITA			SVN							
year	**OTB**	**OTB**	**TBB**	**Total Italy**	**GND**	**GNS**	**GTR**	**LLS**	**OTB**	**PS**	**PTM**	**Total Slovenia**
2006		3979.6	236.8	4216.5		1.0	0.1	0.0	2.2			3.3
2007		3434.8		3434.8	0.0	1.4	0.1		4.6	0.0	0.1	6.2

2008		3036.6		3036.6		0.3	0.0		0.8	0.0		1.1
2009		2548.8		2548.8		0.4	0.1	0.0	1.1			1.5
2010		1862.9		1862.9		0.0	0.0		0.1			0.1
2011		1459.6	12.1	1471.7		0.1	0.0		0.2			0.3
2012		1777.0	15.0	1792.0		0.2	0.0		0.2	0.0		0.4
2013	1019.9	2191.6		2191.6		0.2	0.0		0.7			0.9

Moreover, according to the FAO statistics:
(www.fao.org/fishery/statistics/software/fishstatj/en), in the Adriatic Sea, the annual landings of hake (Fig. 4.2.13.4.4.1) in the 1980s and 1990s were estimated at around 2,000-4,000 t, with some peaks over 5,000 tons. A decreasing trend occurred from 1993 to 2000, followed by a positive trend until 2006 and a successive negative trend in the following period

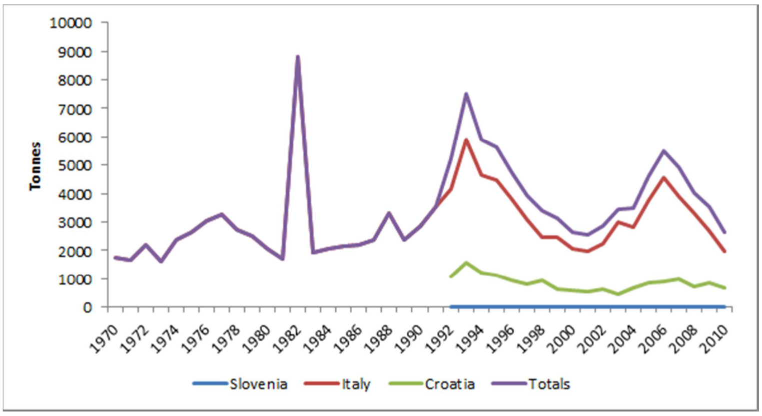

Fig. 4.2.13.4.4.1 FAO landing statistics 1970-2010 for the whole Adriatic Sea.

Slovenian OTB landings accounted on average only for 1 tons by year (DCF official data call), while, as reported in STECF 13-05, Croatia showed higher catches (landings and discards) comprised between 700 and 900 tons (Croatian DemMon Project). Also in Croatia otter trawl represents the main gear in hake fishery, followed by long line and gill-nets activity.

Monitoring of demersal resources in Croatian territorial waters has been established through DemMon project starting from 2002/2003. Data has been collected on the board on fishing vessel and on the landing ports. Sampling methodology is similar to the DCF requirements. Starting from 2012/2013, data collection is adjusted to the DCF.

4.2.13.4.5 Discards

Information on discard documented during EWG 14-09 from Italian Data Collection Programis related to trawlers in 2006, 2011, 2012 and 2013. From Croatia discard data were available only for tralwers in 2013.

Tab. 4.2.13.4.5.1. Hake in GSA 17. Discard (tonnes) for trawlers, 2011-2013 from DCF data.

country	year	gear	discards
ITA	2011	OTB	8.9
ITA	2012	OTB	36.9
ITA	2013	OTB	2.9
HRV	2013	OTB	190.6

4.2.13.4.6 Fishing Effort

Table 4.2.13.4.6.1 reveals an overall decreasing trend in nominal effort of the bottom otter trawl fleet until 2010 and then a decrease in the last three years (Fig. 4.2.13.4.6.1).

Table 4.2.13.4.6.1. Annual effort (Nominal effort) by gears in GSA 17 for Italy 2004-2013, Slovenia 2005-2013 and Croatia 2012-2013.

NOMINAL EFFORT					
	HRV				
year	GNS	GTR	LLS	OTB	TBB
2012	287462	252696	97160	940327	6384
2013	288653	228843	192537	803909	5540
	ITA				
	GNS	GTR	LLS	OTB	TBB
2004	497401	255722		993709	352711
2005	553394	182223		1003935	317743
2006	431553	144667	542	904401	380480
2007	317357	182920	605	970452	435986
2008	223333	111262		911520	354691
2009	182151	118759		929904	289347
2010	212273	157687		952346	254499
2011	301619	122996		764298	164095
2012	295241	188236		701038	271182
2013	270396	137858		600682	230806
	SVN				
	GNS	GTR	LLS	OTB	
2004					
2005	3626	6128	98	11266	
2006	3705	6777	220	17941	
2007	4433	10243	63	20442	
2008	6634	10941	26	22020	
2009	7616	11023	98	25110	
2010	10359	11655	49	25983	
2011	8515	15602	65	23578	
2012	12305	15149	111	19206	
2013	10796	24177	35	14212	

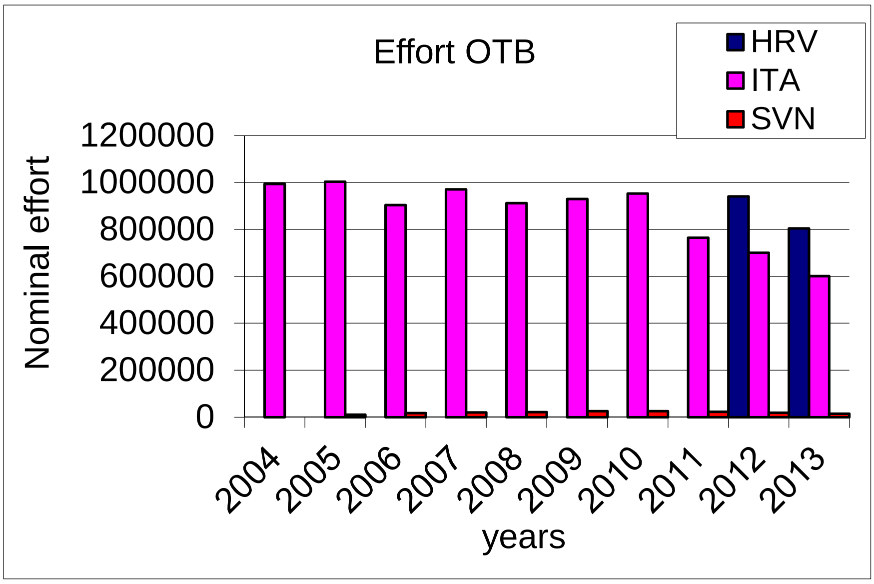

Fig. 4.2.13.4.6.1. Nominal effort from DCF for Croatia (2012-2013), Slovenia (2005-2013) and Italy (2004-2013).

4.2.13.5 Scientific surveys

4.2.13.5.1 MEDITS

4.2.13.5.2 Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method. In GSA 17 the following number of hauls was reported per depth stratum (Tab. 4.2.13.5.2.1).

Tab. 4.2.13.5.2.1. Number of hauls per year and depth stratum in GSA 17, 2002-2013.

Year	10-50m	50-100m	100-200m	200-500m	500-800m	Total[1]
2002	59	56	53	11	1	180
2003	60	57	50	13	1	181
2004	63	66	39	12	1	181
2005	64	64	43	11		182
2006	60	66	43	11		180
2007	67	60	45	10		182
2008	65	64	43	10		182
2009	63	66	43	11		183
2010	65	59	49	9		182
2011	62	64	49	10		185
2012	62	63	46	11		182
2013	69	53	46	12		239

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation around the stratified mean is expressed as standard deviation.

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

[1] The number of hauls here reported are related to the data in DCF database.

Length distributions represent the number of individual per km^2 (Cochran, 1977).

4.2.13.5.3 Geographical distribution patterns

The distribution of hake in GSA 17 during spring-summer, is shown in the maps below (Sabatella and Piccinetti 2004).

The picture on the left provides details on the depth, increasing with darker colour (0-50, 50-100, 100-200, 200-800, > 800 m). The picture on the right displays the hake densities at sea from MEDITS trawl survey in the second half of the 1990s, expressed as number of individuals per square kilometer (Fig. 4.2.13.5.3.1). In the GSA 17, higher densities are observed in the southern part and at depths between 100 and 200 m.

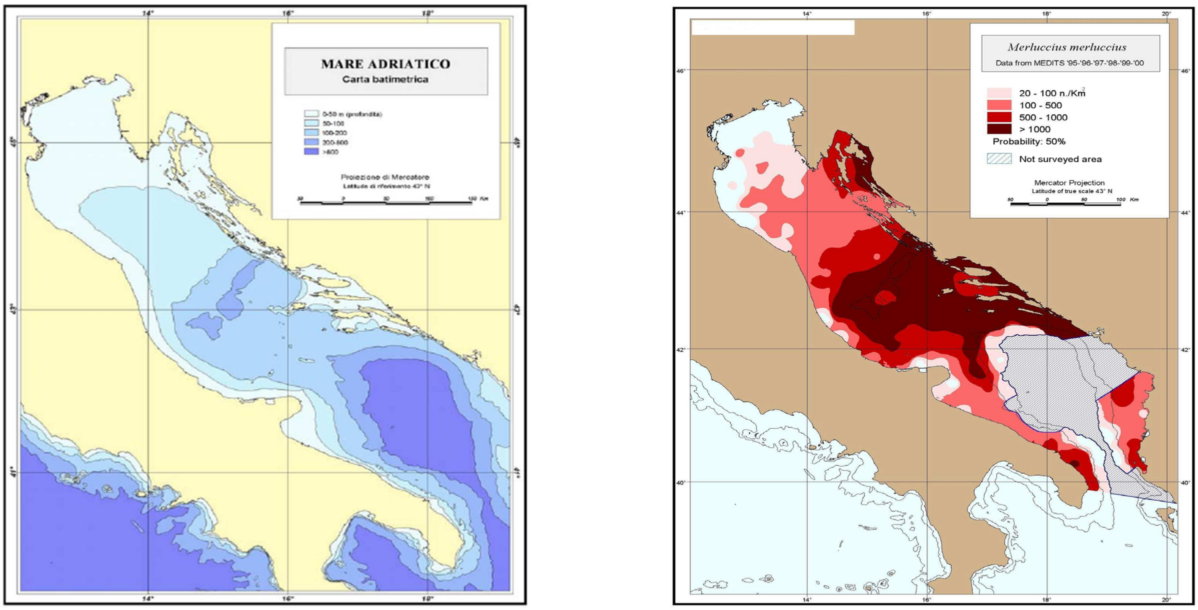

Figure 4.2.13.5.3.1. Map of Adriatic sea (left) and spatial distribution of *M. merluccius* in Adriatic Sea (right).

In the subsequent three maps, again from Sabatella and Piccinetti (2004), densities at sea are plotted taking into account different length ranges (increasing in the maps from left to right). In particular, individuals with length lower than 12 cm are concentrated in the southern part of the GSA 17. The individuals with length between 12 and 20 cm display the same pattern but are more diffuse; the same pattern is observed also for the individuals with length higher than 20 cm, but they are more abundant on the eastern side of Adriatic.

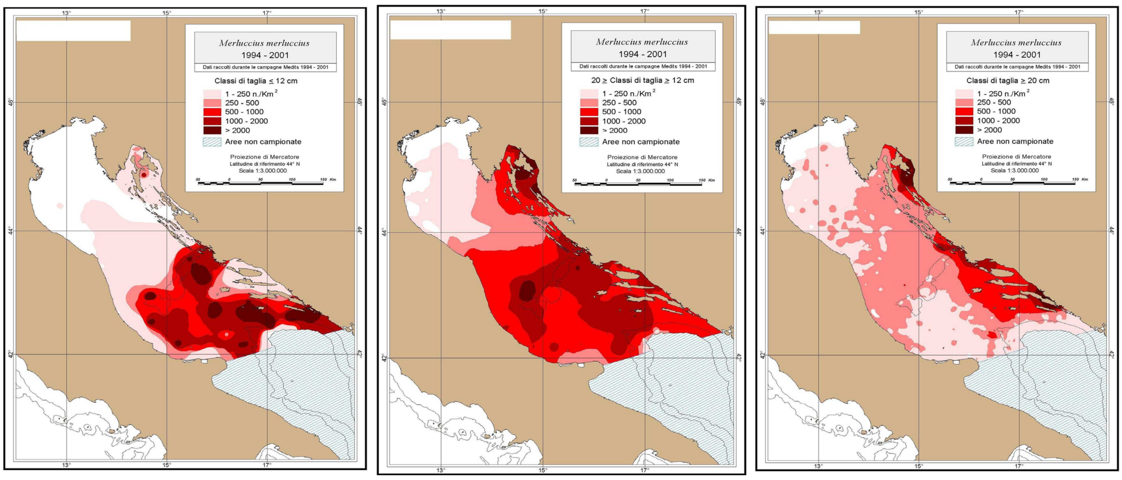

Figure 4.2.13.5.3.2. Spatial distribution of *M. merluccius* in GSA 17.

4.2.13.5.4 Trends in abundance and biomass

Abundance indices from MEDITS survey have been recalculated using the data available during STECF EWG 14-09 by means of ELASMOSTAT routine (Facchini et al. 2013). Figure 4.2.13.5.4.1 displays the estimated trend in hake abundance and biomass in GSA 17.

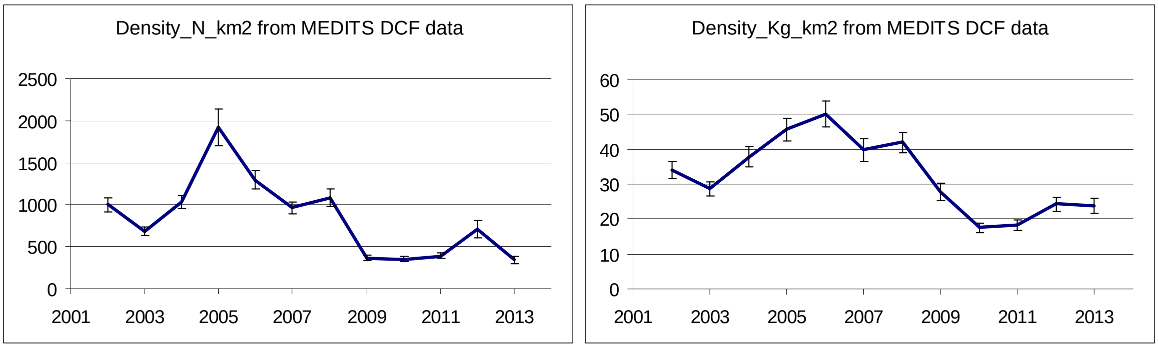

Fig. 4.2.13.5.4.1. Hake in GSA 17. Density (n/km^2) and biomass (kg/km^2) indices from the MEDITS survey.

4.2.13.5.5 Trends in abundance by length or age

The following Fig. 4.2.13.5.5.1- 4.2.13.5.5.4 display the stratified abundance indices by length classes as estimated by ELASMOSTAT routine on DCF database of GSA 17 in 2002-2013. However, several discrepancies have been found among the indices derived as sum of the LFDs and the aggregated indices especially for 2012.

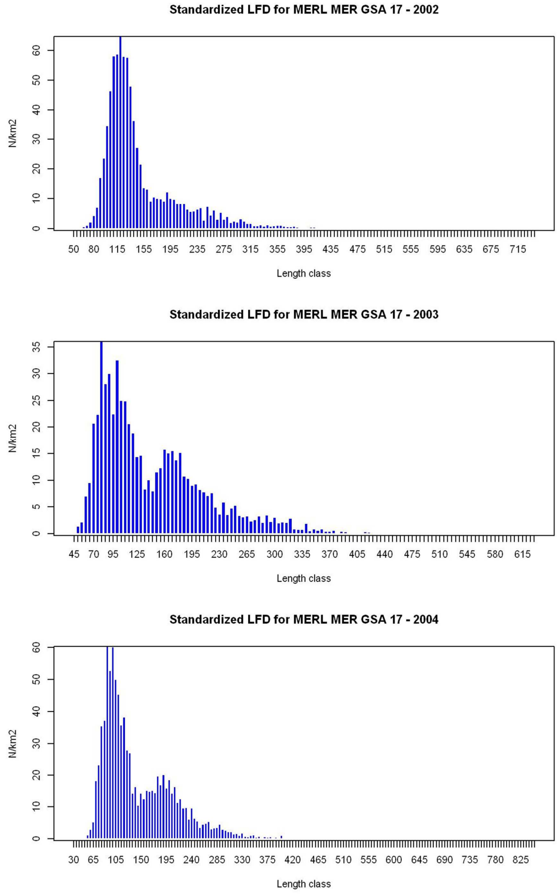

Fig. 4.2.13.5.5.1. Hake in GSA 17. Stratified abundance indices by size, 2002-2004.

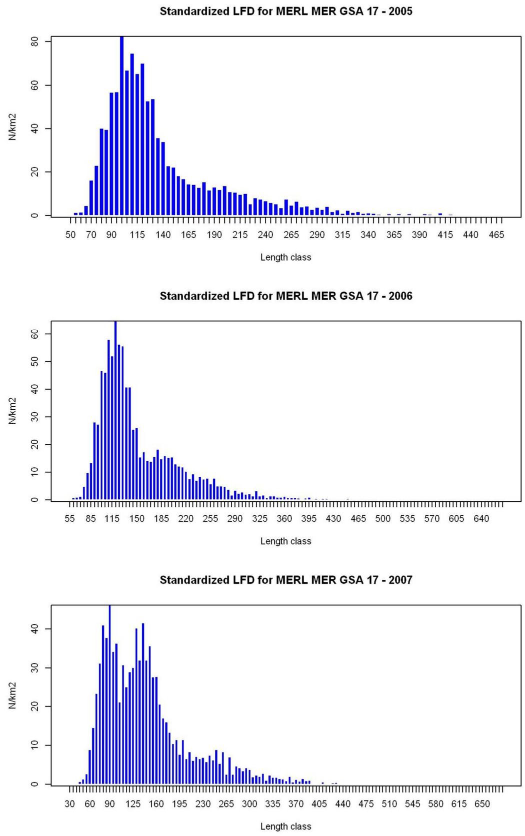

Fig. 4.2.13.5.5.2. Hake in GSA 17. Stratified abundance indices by size, 2005-2007.

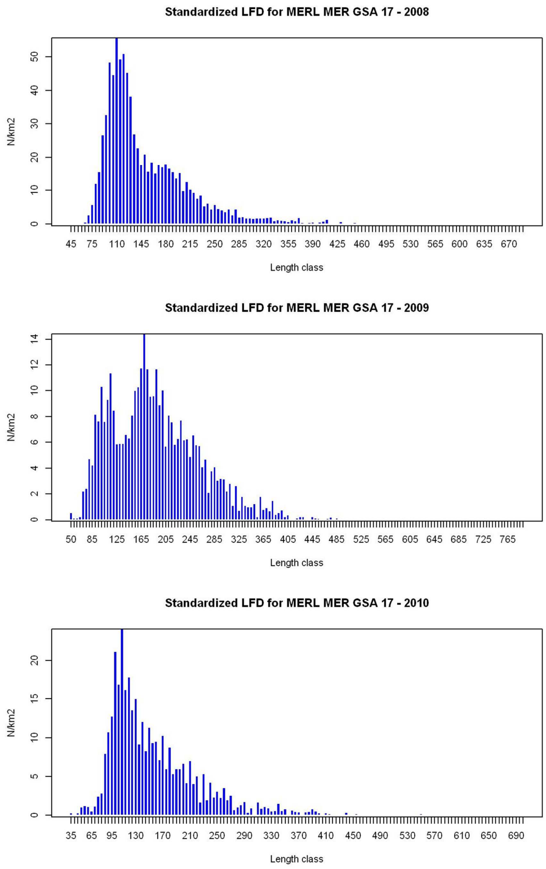

Fig. 4.2.13.5.5.3. Hake in GSA 17. Stratified abundance indices by size, 2008-2010.

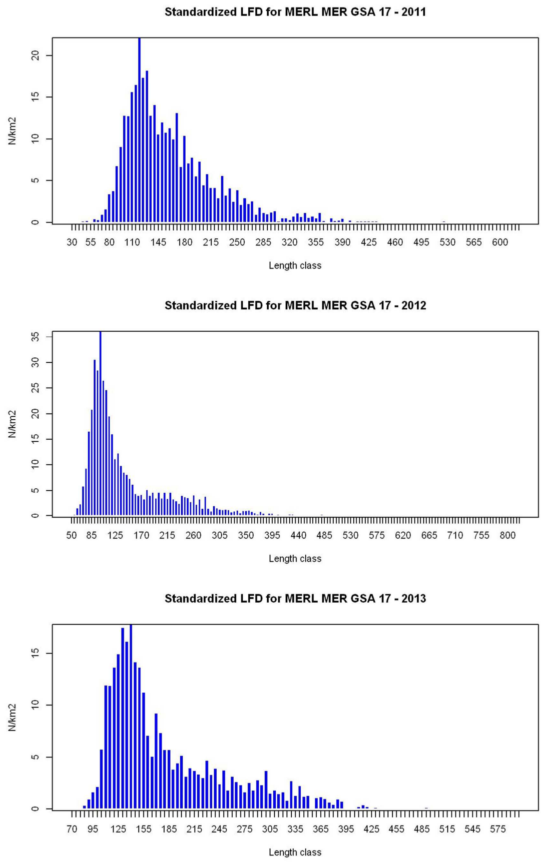

Fig. 4.2.13.5.5.4. Hake in GSA 17. Stratified abundance indices by size, 2011-2013.

4.2.13.5.6 Trends in growth

No specific analyses were conducted during EWG-14-09.

4.2.13.5.7 Trends in maturity

No specific analyses were conducted during EWG-14-09.

4.2.13.6 Assessment of historic stock parameters

Assessment based on fishery dependent data was carried out in SGMED-10-02, but results were rejected during SGMED-10-03, due discrepancies observed in catch at length data. A preliminary assessment using Length Cohort Analysis (LCA) can be found in the report of SGMED-08-04 working group.

An analytical assessment performed with XSA and VIT was performed during STECF EWG 12-19 because of the availability of commercial data for Croatia, as well as more consistent survey data.

4.2.13.6.1 Method 1-2: XSA-SS3

4.2.13.6.1.1 Justification

An attempt to perform an XSA run has been made, thanks to the availability of data for Croatian OTB from 2007 to 2011 from the previous assessment made in 2012 (EWG 13-05). Assuming the LFDs and production for Croatian LLS equal to 2008 (the only available, from the 2012 assessment) a reconstruction of LLS for the other years have been derived. For 2012 an average value between 2011 and 2013 has been assumed for LFDs of Croatian OTB.
For Italian OTB DCF data have been used; for OTB discard in Italian OTB, the last three years have been used to reconstruct the previous discard. For Croatian OTB, the discard has been reconstructed according to the information from the 2012 assessment, while for 2013 the discard available from DCF has been used.

Statistical age slicing script developed by Scott et al. (2012) during EWG 11-12 has then been used to transform reconstructed commercial, MEDITS and SOLEMON LFDs in age distributions in order to apply XSA and SS3 models.

Nevertheless, the XSA showed a strong negative trend in 2012 residuals, highlighting serious inconsistencies in the input data, probably due to the big number of assumptions and the issues in MEDITS data in 2012 (see data quality paragraph). Moreover with the input data utilized in the SS3 method the model could not converge, such outcome may be related to issues both in commercial catch and surveys data. For these reasons, the experts and the group decided to not present results on these two models, preferring to present VIT analysis on the only year complete from DCF data (2013).

4.2.13.6.2 Method 3: VIT

4.2.13.6.2.1 Justification

On the basis of the data availability during STECF EWG 14-09 (Italian data 2006-2013, Slovenian 2005-2013 and Croatian only for trawlers in 2013), a VIT (Lleonart and Salat, 2000) run has been performed on 2013 under steady state hypothesis.

4.2.13.6.2.2 Input parameters

Catch at length data 2013 from Italy and Croatia has been used in the analysis. The data related to the previous years were not utilised due to the absence of catch statistics from the Croatian fleet, which, according to the previous assessment and also to DCF data on 2013, represents a large part of the hake catches. Italian and Croatian catch at age data were not used due to the absence of knowledge about the growth parameters used for transforming length distributions in age distributions. The catches of Italian TBB and Slovenian OTB were not included in the following analyses because representing less than the 1% of the total landing.

Length frequency distributions of Italian OTB for 2013 and Croatian OTB catches (Fig. 4.2.13.6.2.2.1) were divided in age classes by statistical slicing (assuming gamma and normal distribution of the cohorts respectively for Italian and Croatian OTB) developed by Scott et al. (2012) during EWG 11-12 (Fig. 4.2.13.6.2.2.2). LDF were divided up to the age class 5+. Analysis was performed by sex combined using the VBGF parameters assuming fast growth.

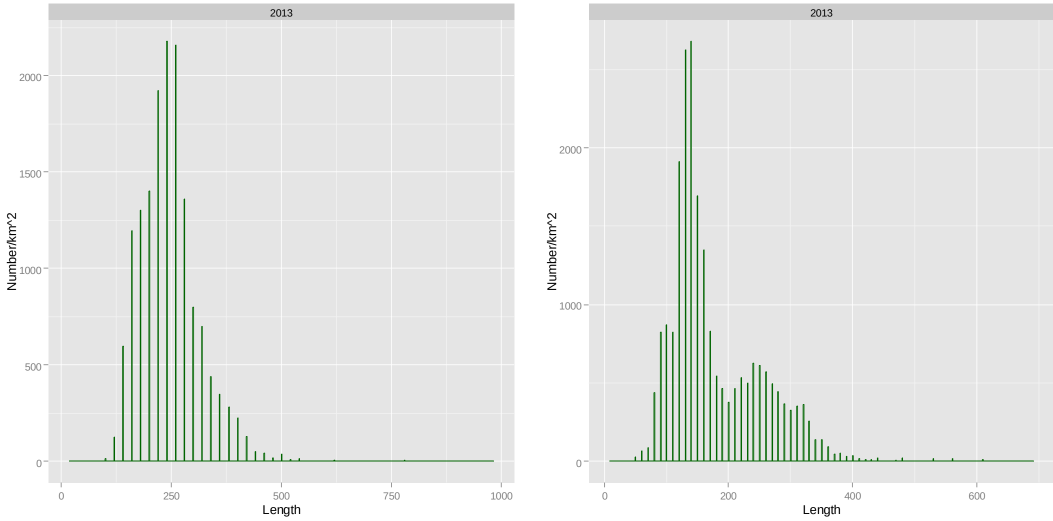

Fig. 4.2.13.6.2.2.1. Hake in GSA 17. Commercial length frequency distributions of OTB Italian (left) and OTB Croatian catches (right), landing and discard.

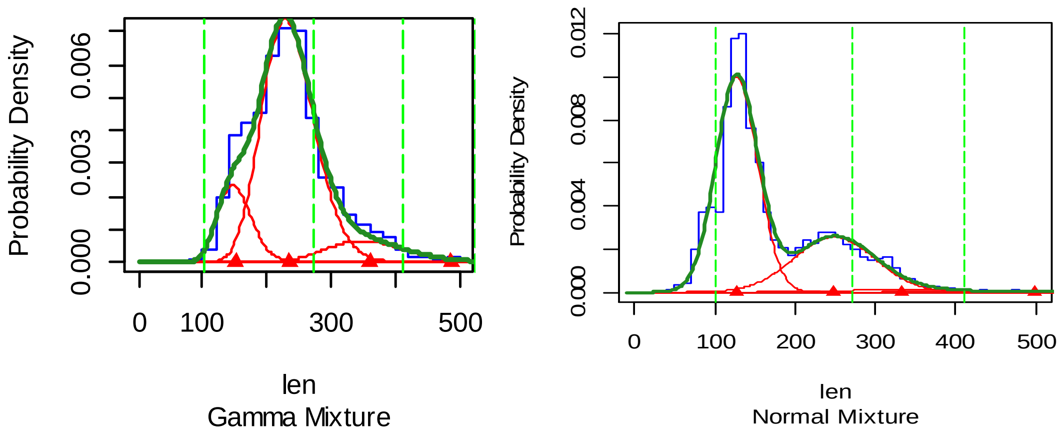

Fig. 4.2.13.6.2.2.2. Hake in GSA 17. Statistical age slicing of the commercial length frequency distribution of Italian (left) and Croatian (right) OTB catches (2013).

Table 4.2.13.6.2.2.1. Hake in GSA 17. Input data parameters of the VIT.

Growth parameters						
Fast growth	**L_{inf}**	**k**	**t_0**			
2013	104 cm	0.2 y^{-1}	-0.01 y			
Length-weight relationships						
		a	**b**			
2013		0.004	3.17			
Maturity at Age (GSA 18)						
ages	**0**	**1**	**2**	**3**	**4**	**5+**
2013	0	0.5	0.79	0.89	1	1
Natural mortality (M) (GSA 18 Probiom)						
ages	**0**	**1**	**2**	**3**	**4**	**5+**
2013	1.16	0.58	0.46	0.41	0.39	0.35

Terminal F has been set equal to 0.3.

Table 4.2.13.6.2.2.2. Hake in GSA 17. Catch ate age data (landing and discard) by gear used in VIT.

Ages	OTB ITA	OTB CRO
0	2 420 862	14 499 603
1	11 462 640	7 218 066
2	1 532 706	432 347
3	23 979	110 230
4	24	0
5	8 339	0

4.2.13.6.2.3 Results

As shows the comparison between the output and the observed catches, VIT seems to reconstruct consistently the catches.

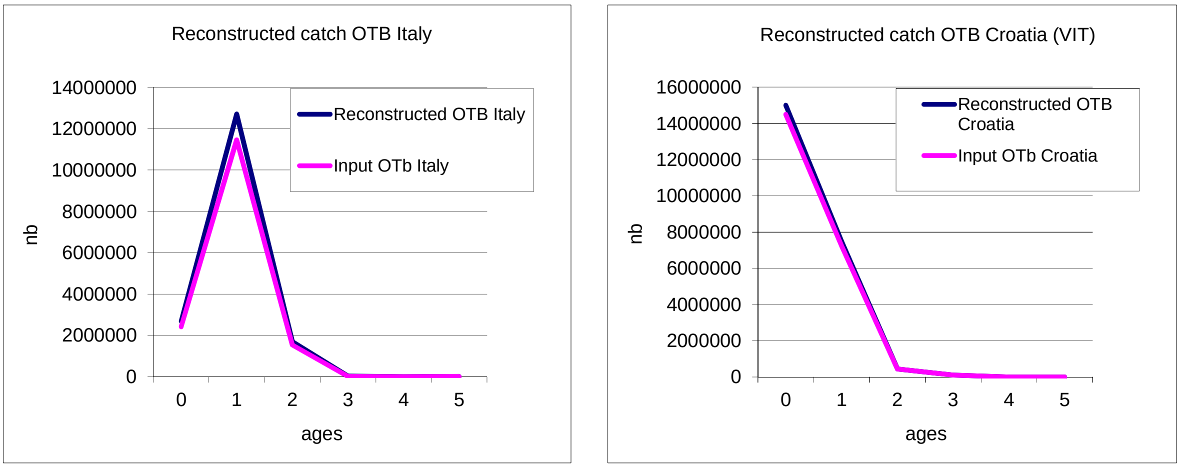

Figure 4.2.13.6.2.3.1. Hake in GSA 17. Comparison between observed and reconstructed catches for Italian OTB (left) and Croatian OTB (right) catches.

The figures 4.2.13.6.2.3.1 and the table 4.2.13.6.2.3.1 presents the fishing mortality (overall and by fleet) from the VIT run.

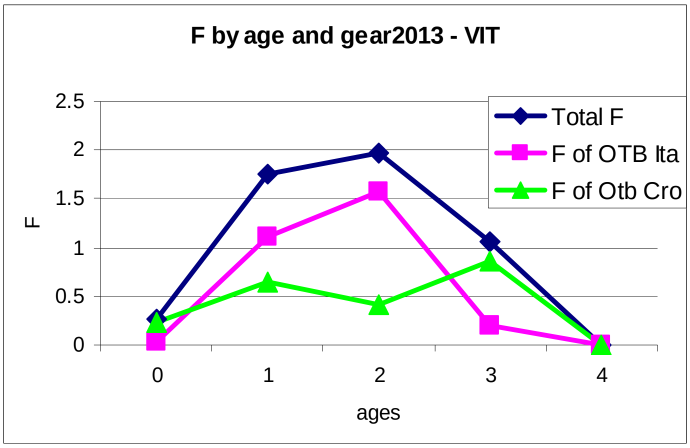

Fig. 4.2.13.6.2.3.1. Hake in GSA 17. Fishing mortality (overall and by fleet) for 2013 from VIT run.

Table 4.2.13.6.2.3.1. Hake in GSA 17. Total and fishing mortality (overall and by fleet) for 2013 from VIT run.

Age	Z	Overall F	F of OTB Ita	F of Otb Cro
0	1.43	0.27	0.04	0.23
1	2.33	1.75	1.10	0.65
2	2.44	1.98	1.57	0.41
3	1.47	1.06	0.20	0.86
4	0.35	0.001	0.001	0.00
5	0.60	0.30	0.30	0.00
Mean (0-4)	1.60	1.01	0.58	0.43

The 2013 estimate of fishing mortality (F_{0-4}) is 1.01, the highest values of F are for ages 1 to 3.

4.2.13.7 Medium term prediction

No medium term prediction have been performed during STECF EWG 14-09.

4.2.13.8 Long term prediction

4.2.13.8.1 Justification

Yield per recruit analyses (YPR) were conducted based on the exploitation pattern in 2013 resulting from VIT model, using the same population parameters.

The YPR analyses allowed the estimate of $F_{0.1}$, which is considered as a proxy of F_{MSY}.

4.2.13.8.2 Input parameters

The input parameters were the same utilized in the VIT run.

4.2.13.8.3 Results

Fig. 4.2.13.8.3.1 shows the results of the YPR analyses. Table 4.2.13.8.3.1 shows the reference fishing mortality, along with the reference points $F_{0.1}$ and the F_{max} from VIT model.

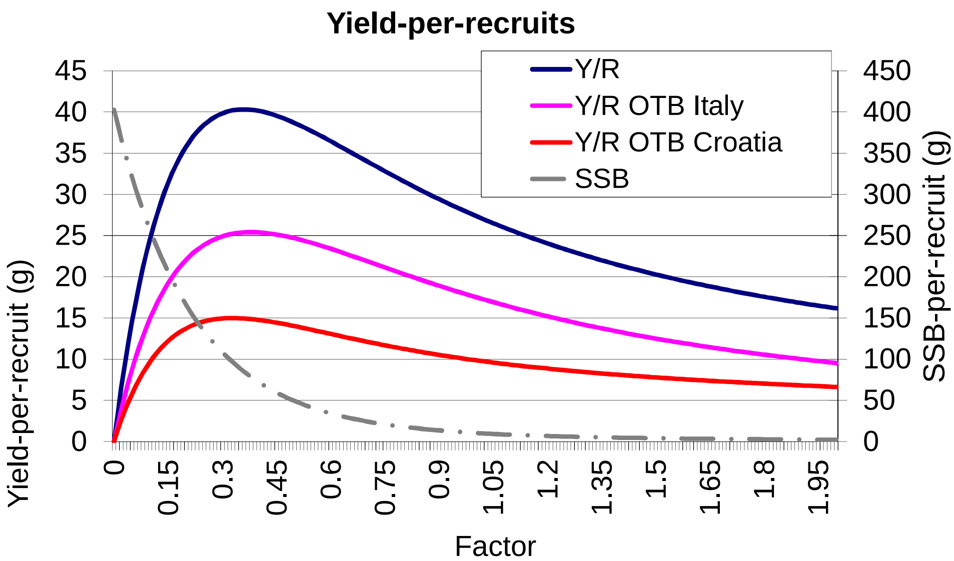

Fig. 4.2.13.8.3.1. Hake in GSA 17. Results summarising the yield per recruit analysis performed on 2013 data (VIT model)

Table. 4.2.13.8.3.1. Hake in GSA 17. Reference points estimated with the YPR analyses.

	Factor	F	Y/R	B/R	SSB	Y/R OTB Italy	Y/R OTB Croatia
F=0	0.00	0.00	0.0	450.1	402.6	0.0	0.0
F0.1	0.28	0.28	39.4	143.5	117.9	24.6	14.8
Fmax OTB Cro	0.34	0.34	40.2	119.1	95.9	25.2	15.0
Fmax	0.37	0.37	40.3	106.9	84.9	25.4	14.9
Fmax OTB Ita	0.39	0.39	40.3	99.6	78.3	25.4	14.9
F curr	1.01	1.02	27.4	20.2	10.4	17.6	9.9
double F	2.00	2.02	16.2	7.3	2.1	9.5	6.6

4.2.13.9 Data quality

During the STECF EWG 14-09 was not possible to apply an analytical methodology to update the assessment of hake stock in the GSA 17 for the following reasons:

- Absence of catch data from Croatian OTB for 2012;
- Absence of data from Croatian LLS and GNS both in terms of total landing and LFDs for 2012 and 2013.
- Several inconsistencies have been detected in the DCF data, in particular:
  Lack of Croatian hauls in DCF-DB for 2012;
  A greater number of hauls (59) reported in DCF-DB for 2013, maybe due to an inter-calibration exercise occurred in 2013. To keep consistency in the time series, these hauls have been eliminated in the estimation of abundance indices;
  Total abundance index in 2012 (706 Number /km^2) different from the sum of LFD (419 Number /km^2). In order to detect the main reasons of this inconsistency, a run of RoME has been performed on 2012 TA, TB and TC extracted from DCF database.
  RoME run highlighted:
    - Haul 526 MERL MER : NB_TOTAL doesn't equal NB_F+NB_M+NB_I in TB
    - Haul 538 MERL MER : NB_TOTAL doesn't equal NB_F+NB_M+NB_I in TB
    - Haul 523 length measurements MERL MER not found in TC
    - Haul 557 length measurements MERL MER not found in TC
    - Haul 559 length measurements MERL MER not found in TC

Other problems detected, not compromising the performances of the assessment were:

- The sum of product on DCF catch at age data differs of 40% for discard OTB Croatia in 2013, 20% for landing OTB Croatia in 2013 and 30% for Italian OTB in 2011 (landings). For Italian data the mean weight by age in the discard is present only for 2012. SOP correction has been applied in the attempt described in paragraph 4.2.13.6.1.

- Italian LFDs of OTB: The size structures of landings in 2006 have a different distribution respect to 2007-2011 ones. It is quite difficult to understand if the reasons of such discrepancies are related to changes of the fishing grounds exploited by the fleet or in changes in the sampling design. For this reasons, both in the previous assessment performed in 2012 and in the attempt described in paragraph 4.2.13.6.1, 2006 has not been used.
- Absence of discard data of Italian OTB in 2009 and 2010, although scientific papers reported the presence of discard for the species in the GSA17 (e.g. Sánchez et al. 2007; Lucchetti, 2008). However, this information had been reconstructed on the basis of the last three years (when the discard data is available) in the assessment attempt described in paragraph 4.2.13.6.1.
- Data on sampling size seems quite imbalanced between Croatia (10,491 number of length measurement landing) and Italy (less than 100 by gear and year).

4.2.13.10 Scientific advice

EWG 14-09 is unable to provide any scientific advice of the state of the SSB given the preliminary state of the data and analyses.

4.2.13.11 Short term considerations

4.2.13.11.1 State of the spawning stock size

EWG 14-09 is unable to provide any scientific advice of the state of the SSB given the preliminary state of the data and analyses. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.13.11.2 State of recruitment

EWG 14-09 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

4.2.13.11.3 State of exploitation

The current F (1.01) is larger than F_{MSY} (0.28), which indicates that hake in GSA 17 is exploited unsustainably.

The overall fishing mortality is divided in 0.58 due to Italian OTB and 0.43 due to Croatian OTB.

4.2.13.12 Management recommendations

STECF EWG 14-09 advise the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

4.2.14 STOCK ASSESSMENT OF RED MULLET IN GSA 25

4.2.14.1 Stock Identification

Red mullet is a common demersal fish in the Mediterranean Sea, found in depths ranging from 10-200 m, and mostly distributed in depths less than 100 m. It inhabits sandy and muddy bottoms. The species in GSA 25 is considered as a single stock, though this has not been evidenced by studies on population structure (Fig. 4.2.14.1.1).

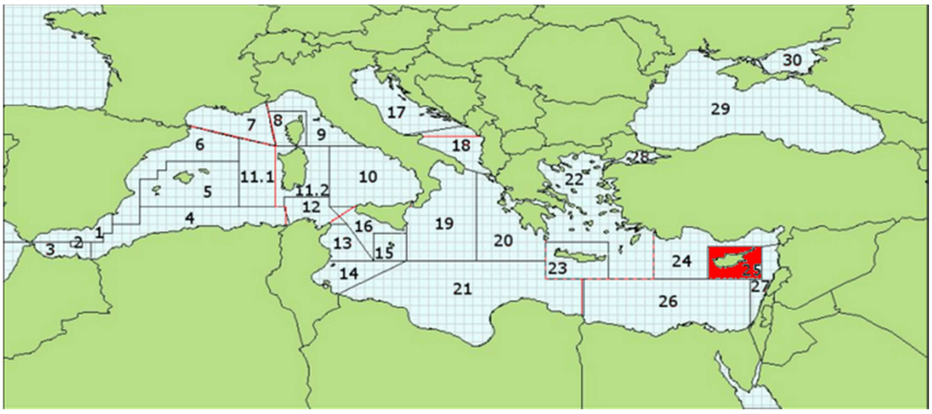

Fig. 4.2.14.1.1. Geographical location of GSA 25.

4.2.14.2 Growth

The von Bertalanffy growth parameters of red mullet in GSA 25 were estimated using otolith readings; the estimates for sex combined data are the following (Charilaou, 2011): L_{inf} = 26 cm, K=0.26 and t0=-0.4 y. Parameters of the length-weight relationship, related to sex combined data, are (Charilaou, 2011): a=0.00789, b = 3.12 (for length expressed in cm).

The data used for the growth parameters were collected under the Cyprus National Data Collection Programme.

4.2.14.3 Maturity

The period of reproductive activity of red mullet is in spring until early summer (March-June), with subsequent recruitment taking place in summer. Length at maturity has been estimated at 9 cm for males and females combined within the framework of the Cyprus National Fisheries Data Collection Programme (Charilaou, 2011).

The maturity ogive of the stock (sex combined), is presented in Table 4.2.14.3.1. Data used were collected under the Cyprus National Programme (Charilaou, 2011).

Tab. 4.2.14.3.1. Red mullet in GSA 25. Maturity-at-age.

Age	Prop. matures
0	0.09
1	0.72
2	0.93
3	0.98
4	0.99
5+	1

4.2.14.4 Fisheries

4.2.14.4.1 General description of Fisheries

Red mullet in GSA 25 is exploited by the artisanal fleet using set nets (basically trammel nets - GTR) and by the bottom otter trawlers - OTB. In both fisheries the species is exploited with a number of other demersal species, including *Sparisoma cretense*, *Octopus vulgaris*, *Sepia officinalis*, *Serranus cabrilla*, *Scorpaena* spp., Labridae, *Diplodus* spp., *Boops boops*, *Pagellus erythrinus*, *Siganus* spp. (Charilaou, 2011).

On average 51% of total red mullet landings in GSA 25 came from bottom otter trawlers in 2005-2013 (Fig. 4.2.14.4.1.1). The remaining catches came from small-scale vessels measuring up to a maximum length overall (LOA) of 12 m using trammel nets (gear code GTR).

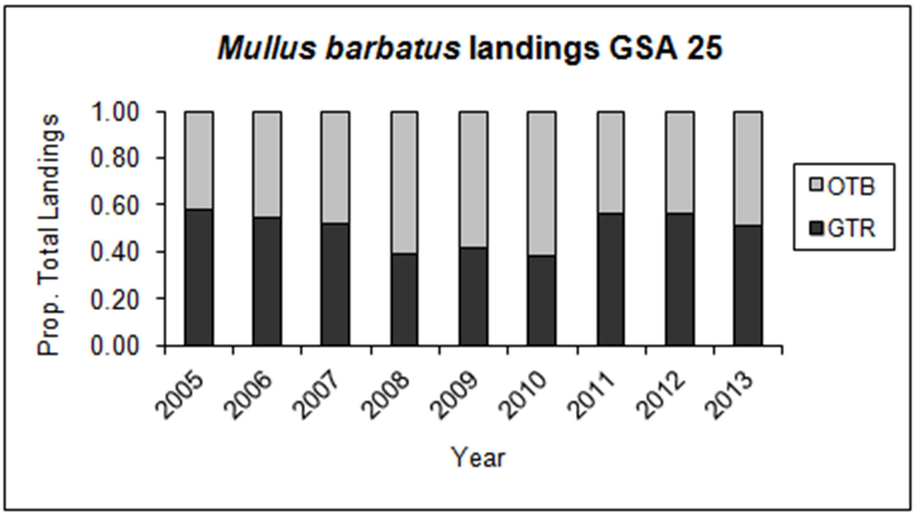

Fig. 4.2.14.4.1.1. Red mullet in GSA 25. Proportion of total landings coming from vessels using bottom otter trawl (OTB) gear and from vessels using trammel nets (GTR).

4.2.14.4.2 Management regulations

The minimum landing size for red mullets (*Mullus* spp.) is 11 cm in European legislation (EC 1967/2006).

Charilaou (2011) provides the following information on regulations in force and degree of observance of regulations for artisanal vessels fishing striped red mullet in GSA 25:

1. Restriction of the maximum number of licenses (fully observed):

- Since 2008 assignment of licensed fishermen in 3 categories (A, B, C), based on their fishing activity and certain criteria.
- Licenses A&B restricted to 369 since September 2013 from 461 in 2012.

2. Restrictions on the use of fishing gears depending on the fishing license category (fully observed).

- For licenses A & B: until March 2011 minimum mesh size of nets at 32mm (open mesh size): fully observed.

- From March 2011 minimum mesh size of nets at 38mm

3. Maximum length of nets (fully observed):

- For boats with license A is 5000m, for boats with license B is 3000m.
- Maximum height of nets: 4m.

4. Restrictions on the time and duration of fishing (fully observed):

- Depending on mesh sizes

5. For licenses C (not fully observed):

- Minimum mesh size of nets at 36mm (open mesh size).
- Prohibition of the use of monofilament nets.
- Maximum length of nets: 600 m.
- Restriction of number of fishing days at 70 days annually, during weekends of certain months.

Charilaou (2011) provides the following information on regulations in force and degree of observance of regulations for bottom otter trawlers fishing red mullet in GSA 25:

- From 2006 maximum number of licenses restricted to 4 and from 2011 to 2: fully observed.
- Closed trawling period from 1st of June until the 7th of November (in force since the mid '80s): fully observed.
- From June 2010 the 40mm diamond shape trawl net replaced by a diamond meshed net of 50mm at the cod-end. From November 2011 minimum mesh size of 50mm diamond in any part of the net. Fully observed.
- Prohibition of bottom trawling at depths less than 50m and at distances less than 0.7 nautical miles off the coast. Fully observed.
- Prohibiton of bottom trawling in the Zygi coastal area, at a distance of 3 nautical miles from the coast. Fully observed.

4.2.14.4.3 Catches

4.2.14.4.4 Landings

Total red mullet landings in the period 2005-2013 decreased from 43.52 tonnes in 2005 to 23.7 tonnes in 2013. Landings of red mullet recorded in 2012 were at the lowest level recorded in the time series with 15.18 tonnes (Tab. 4.2.14.4.4.1; Fig. 4.2.14.4.4.1). The decrease in catches until 2012 was observed both for vessels using trammel nets (from 25.28 tonnes in 2005 to 8.54 tonnes in 2012) and for vessels using bottom otter trawlers (from 18.25 tonnes in 2005 to 6.65 tonnes in 2012). For both fishing categories an increase in landings was observed in 2013 (12 tonnes using trammel nets and 11.7 tonnes using bottom otter trawlers) compared to 2012 with 8.54 tonnes and 6.65 tonnes respectively.

Tab. 4.2.14.4.4.1. Red mullet GSA 25. Total annual landings (t) in 2005-2013 as reported through the EU DCF data call.

	2005	2006	2007	2008	2009	2010	2011	2012	2013
GTR	25.278	18.187	24.316	12.638	10.281	9.869	9.559	8.536	11.997
OTB	18.246	15.541	22.974	20.145	14.472	16.273	7.562	6.646	11.700
Total	43.524	33.728	47.290	32.783	24.753	26.142	17.121	15.182	23.697

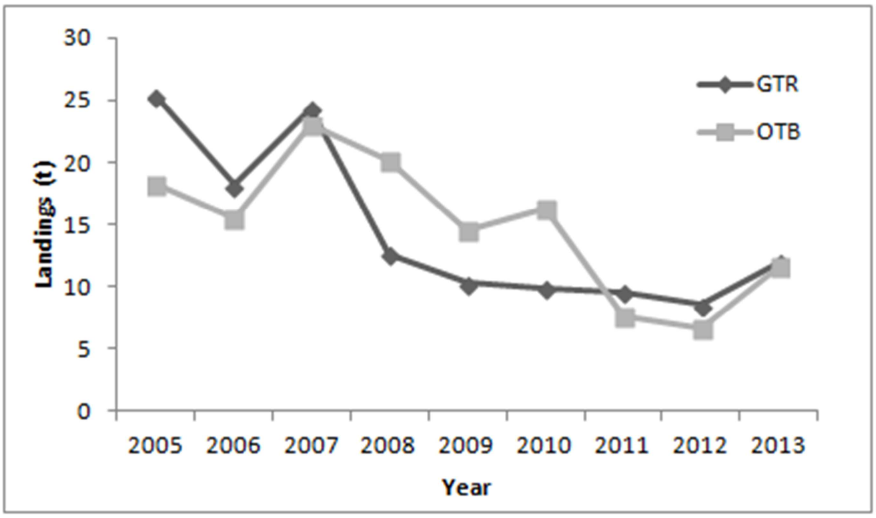

Fig. 4.2.14.4.4.1. Red mullet GSA 25. Total landings in 2005-2013.

Length frequencies of total landings of red mullet from the Cypriot fleet are shown in Figure 4.2.14.4.4.2 below. Landings are dominated by specimens between 11-18 cm length.

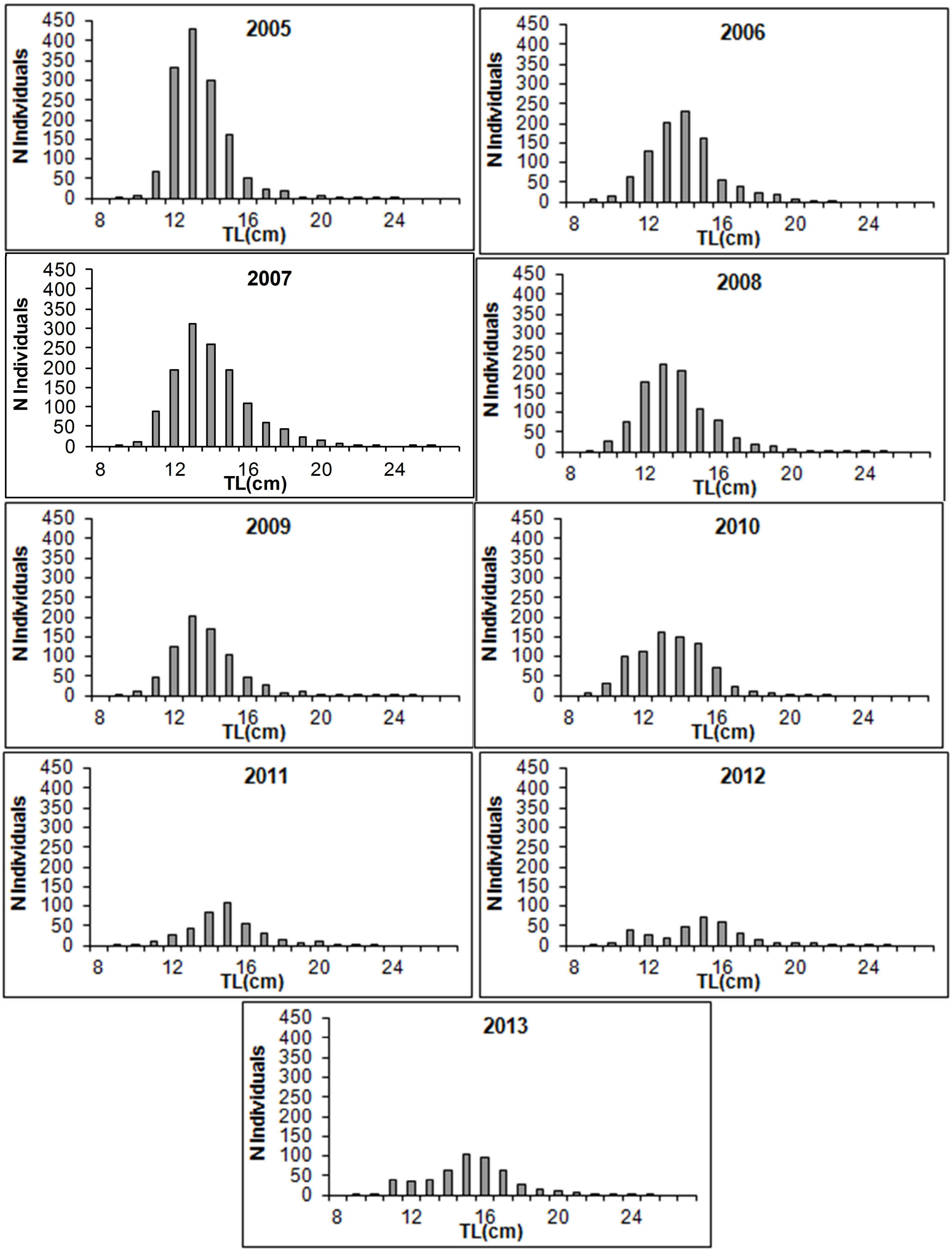

Fig. 4.2.14.4.4.2 Red mullet GSA 25. Length frequency of the landings (thousands individuals).

4.2.14.4.5 Discards

Discards from the bottom trawl were evaluated for the first time in 2006, through a pilot study under the Cyprus National Fisheries Data Collection Programme, and are annually estimated from 2008. The estimated discards for the years 2011, 2012 and 2013 were very low (Fig. 4.2.14.4.5.1). For the time series 2006-2013, discards concentrated mainly in the length classes 8-10 cm (Fig. 4.2.14.4.5.2). Discards from the artisanal fishery are considered negligible.

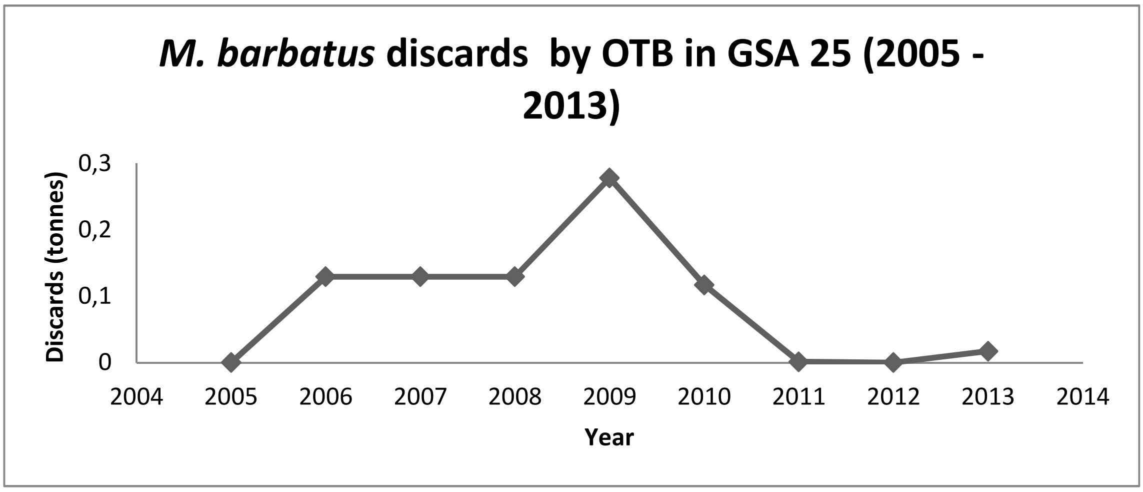

Fig. 4.2.14.4.5.1. Red mullet GSA 25. Total discards in 2005-2013.

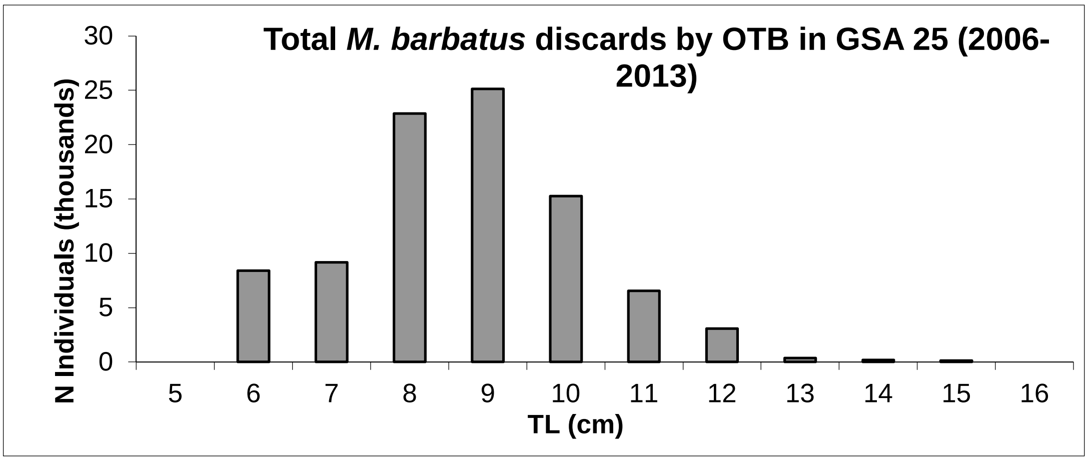

Fig. 4.2.14.4.5.2. Red mullet GSA 25. Length frequency of discards in 2005-2013; numbers are in thousands.

4.2.14.4.6 Fishing Effort

With regards to fishing effort data submitted, Cyprus in response to the EU fisheries Data Collection Framework (DCF) data-call in 2014 only contained information on the total number of vessels using trammel nets; no nominal effort data or data in terms of vessel GT * days at sea was available. There was a 10% increase in the total number of artisanal vessels measuring 6-12 m LOA in 2005-2013 (2005: 390 vessels; 2013: 432 vessels) (Fig. 4.2.14.6.1). The number of artisanal vessels measuring 0-6 m LOA remained constant (2005: 40 vessels; 2013: 41 vessels).

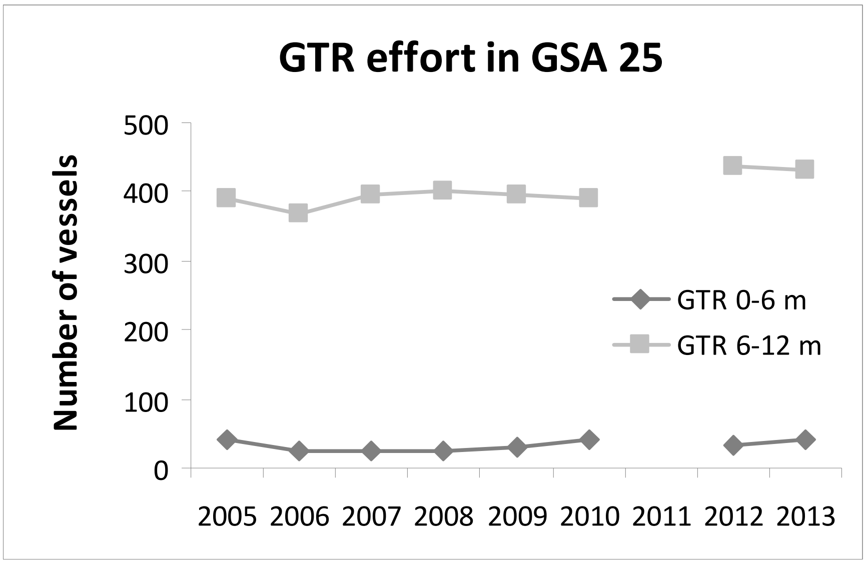

Fig. 4.2.14.6.1. Red mullet in GSA 25. Number of vessels in the 0-6 m and 6-12 m LOA fleet segments using trammel nets during 2005-2013.

With regards to vessels fishing with bottom otter trawlers, DCF data show a 64% decline in nominal fishing effort for Cypriot bottom otter trawlers in 2005-2012 (Fig. 4.2.14.6.2). No fishing nominal fishing effort data for bottom otter trawlers was available for 2013.

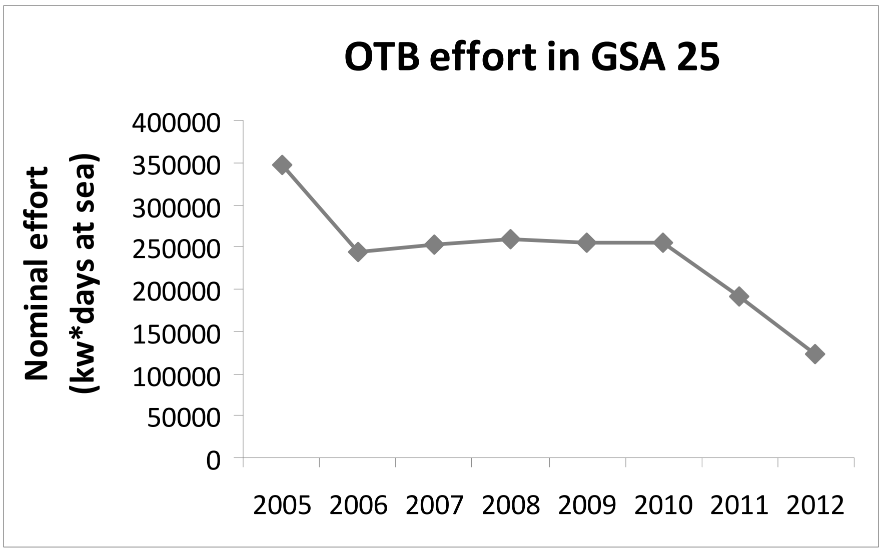

Fig. 4.2.14.6.2. Red mullet in GSA 25. Nominal effort (kW*days at sea) trend of Cypriot bottom otter trawler vessels (OTB) operating during 2005-2012.

Charilaou (2011) report a declining trend in landings per unit effort (LPUE in kg/day) for the artisanal fleet using trammel nets 1985-2010 (Fig. 4.2.14.6.3). Regarding the bottom otter trawl fisheries the highest value of LPUE was in 2010; after an increasing trend from 1996.

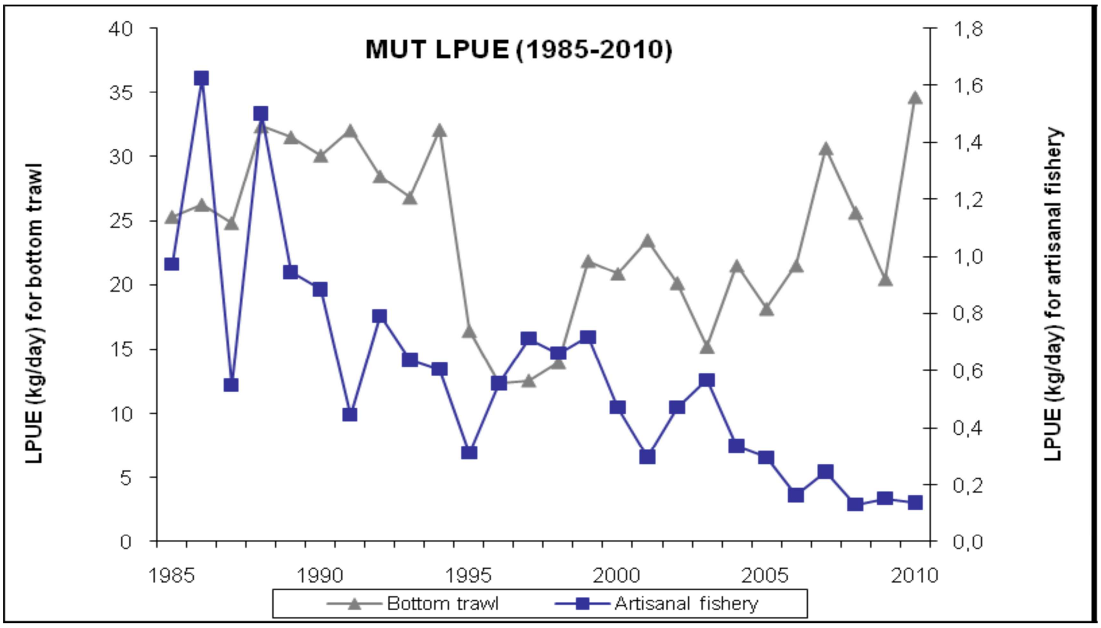

Fig. 4.2.14.6.3. Red mullet GSA in 25. Landings per unit effort (kg/day) for bottom otter trawlers (left axis) and artisanal vessels using trammel nets (right axis) during 1985-2010. *Source:* Charilaou (2011).

4.2.14.5 Scientific surveys: MEDITS

4.2.14.5.1 Methods

In order to collect fisheries independent data, which is a requirement of the EU DCF (Council Regulation 199/2008, Commission Regulation 665/2008, Commission Decision EC 949/2008 and Commission Decision 93/2010); the MEDITS international trawl survey is carried out in GSA 25 on an annual basis. The number of hauls carried out per depth stratum in 2005-2013 is reported below (Tab. 4.2.14.5.1.1).

Tab. 4.2.14.5.1.1. Number of hauls per year and depth stratum in GSA 25, 2005-2013.

Depth (m)	2005	2006	2007	2008	2009	2010	2011	2012	2013
10-50	5	5	5	5	4	5	5	5	5
50-100	8	8	8	9	10	9	9	9	8
100-200	5	5	5	5	5	5	5	5	5
200-500	3	3	3	3	3	3	3	3	3
500-800	4	4	4	5	5	5	4	4	4
Total	25	25	25	27	27	27	26	26	25

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). A limited number of obvious data errors were corrected and catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches of hake, red mullet or pink shrimp (i.e. zero catches were included).

The abundance and biomass indices were subsequently calculated by stratified means (Cochran, 1953; Saville, 1977). This implies weighing average values of the individual standardized catches as well as the variation of each stratum by the respective stratum area:

$$Yst = \Sigma (Yi*Ai) / A \qquad\qquad V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A = total survey area
Ai = area of the i-th stratum
si = standard deviation of the i-th stratum
ni = number of valid hauls of the i-th stratum
n = number of hauls in the GSA
Yi = mean of the i-th stratum
Yst = stratified mean abundance
V(Yst) = variance of the stratified mean

The variation of the stratified mean is then expressed as the standard deviation. Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

4.2.14.5.2 Geographical distribution

Figure 4.2.14.5.2.1 provides the distribution of sampling hauls of the Medits survey in GSA 25, while figure 4.2.14.5.2.2 provides the abundance (n/km^2) distributions of red mullet of 2013 derived from the Medits survey. It is obvious that the highest density of red mullet was found in Agia Napa (east), haul 3of the 100-200m depth zone (15701 n/km^2), followed by haul 25 of the 10-50m zone (7502 n/km^2) in Chrysochou Bay (west) (Fig. 4.2.14.5.2.1).

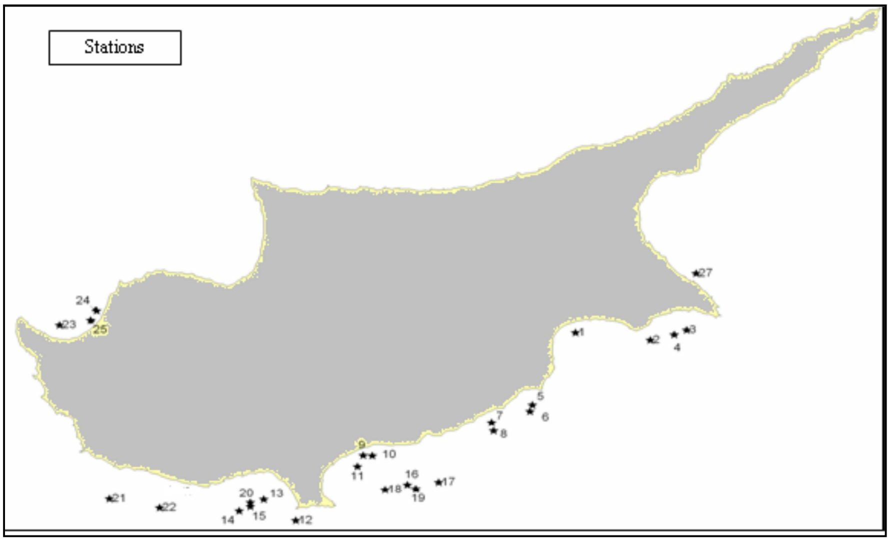

Fig. 4.2.14.5.2.1. Distribution of the hauls sampled during MEDITS survey in GSA 25.

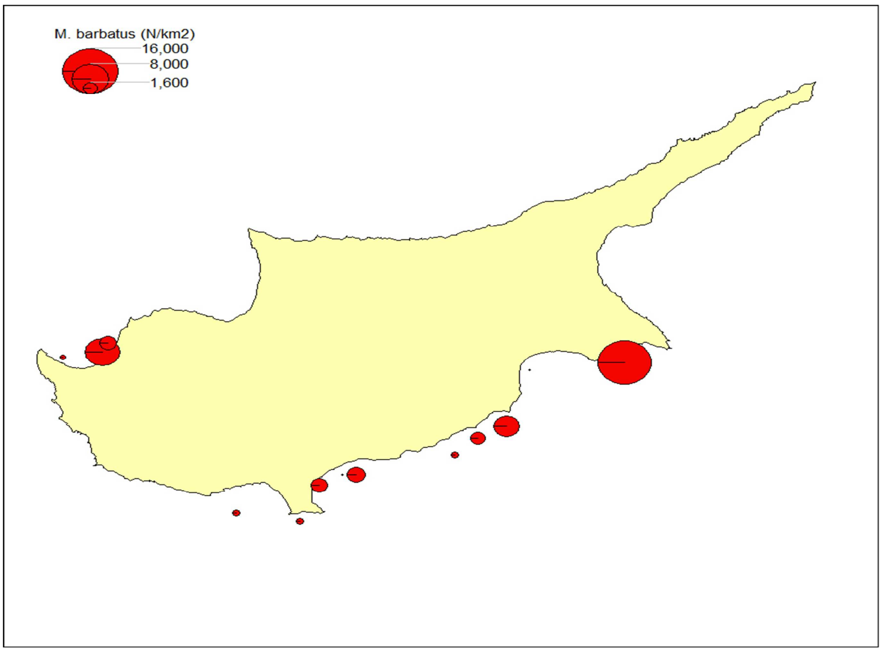

Fig. 4.2.14.5.2.2. Abundance (n/km^2) distribution of red mullet derived from the sampling hauls of the 2013 MEDITS survey.

4.2.14.5.3 Trends in abundance & biomass

Fishery independent information regarding the state of the red mullet stock in GSA 25 can be derived from the international bottom trawl survey MEDITS, which has been carried out in GSA 25 since 2005. MEDITS data was standardised using the routine developed by Facchini et al. (2013).

MEDITS indices calculated for the period 2005-2013 show highest values of numbers (1294.58 n/ km^2) and biomass (40.41 kg/ km^2) of red mullet in 2013, with lower values in the years in 2005-2012 (Fig. 4.2.14.5.3.1; Fig. 4.2.14.5.3.2).

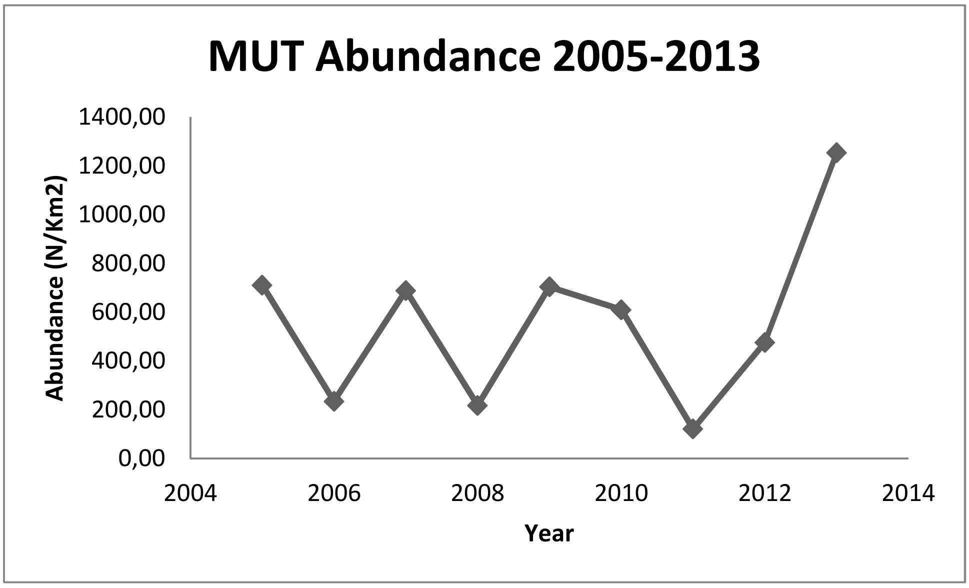

Fig. 4.2.14.5.3.1. Red mullet in GSA 25. Abundance (n/km^2) derived from the sampling hauls of MEDITS survey in 2005 -2013.

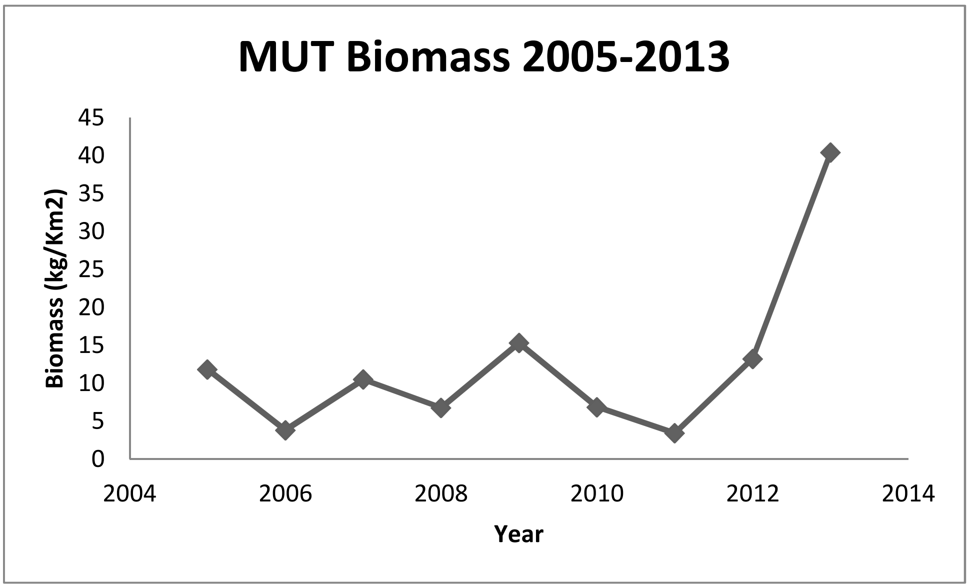

Fig. 4.2.14.5.3.2. Red mullet in GSA 25. Biomass (kg/km^2) derived from the sampling hauls of MEDITS survey in 2005 -2013.

4.2.14.5.4 Trends in abundance by length or age

The following Figure 4.2.14.5.4.1 displays the stratified abundance indices by length (red mullet in GSA 25 in 2005-2013).

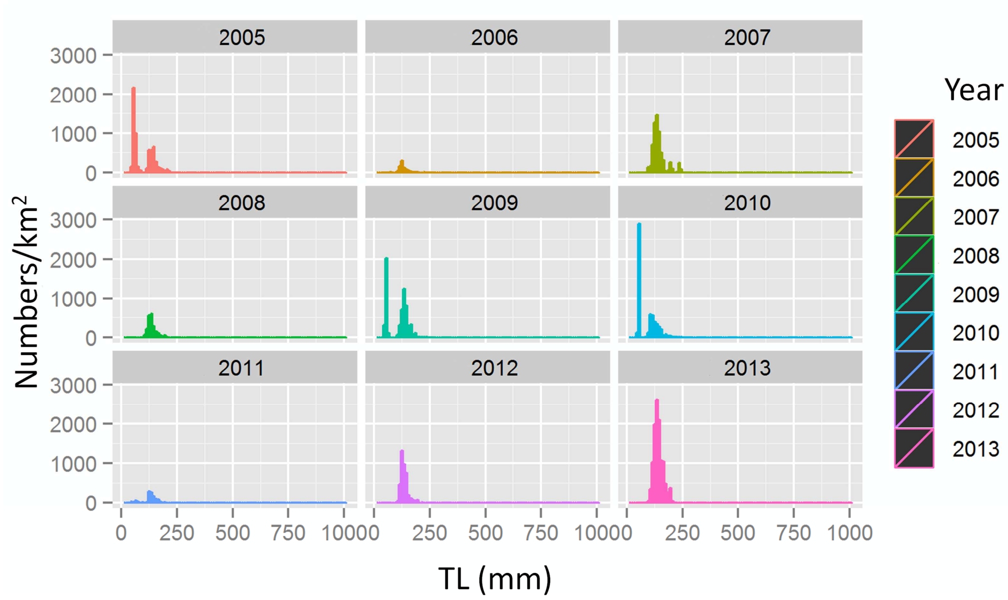

Fig. 4.2.14.5.4.1. Red mullet in GSA 25. Stratified abundance (n/km^2) indices by size class, 2005-2013.

4.2.14.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.14.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.14.6 Assessment of historic stock parameters

4.2.14.6.1 Method 1: Separable VPA

4.2.14.6.2 Justification

The initial derived abundance indices at age data of red mullet from the MEDITS survey, did not give satisfactory results running an XSA, and therefore EWG 14-09 applied a separable VPA method to evaluate the status of this stock.

4.2.14.6.3 Input parameters

For the assessment of the red mullet stock in GSA 25, official DCF data of commercial catches were used (Tab. 4.2.14.6.3.1; Fig. 4.2.14.6.3.1). The analysis was carried out using sex combined data.

Tab. 4.2.14.6.3.1. Red mullet in GSA 25. Catch in numbers by age (thousands)

		Age					
		0	1	2	3	4	5+
Year	2005	3.258	703.954	546.443	212.051	26.479	16.316
	2006	13.689	339.36	416.12	145.584	41.609	20.701
	2007	12.854	498.326	505.399	215.123	66.562	34.274
	2008	11.187	399.641	391.244	144.768	35.277	16.497
	2009	26.37	302.699	338.487	89.075	25.322	6.062
	2010	18.012	340.491	323.085	132.393	21.27	7.928
	2011	8.502	185.496	162.748	34.204	9.413	0.59
	2012	14.057	147.766	112.869	35.02	12.353	2.22
	2013	10.2399	235.672	189.533	54.9015	18.6296	3.635

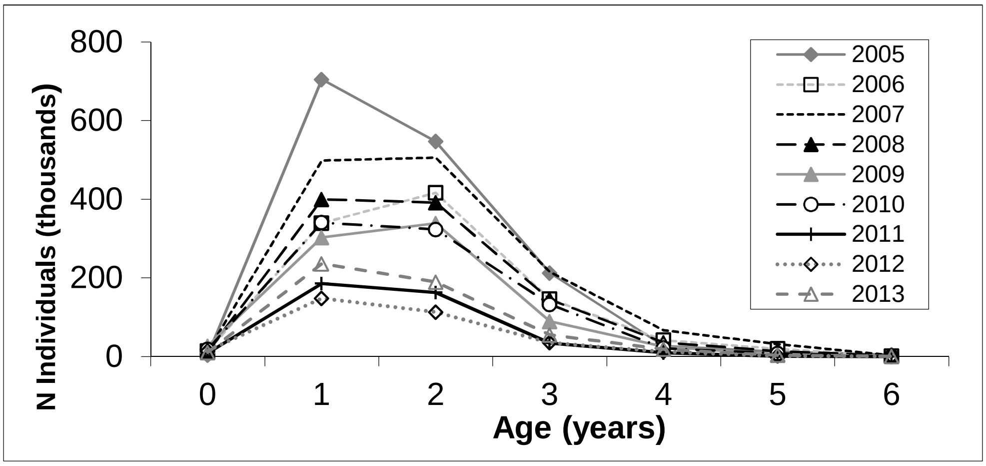

Fig. 4.2.14.6.3.1. Red mullet in GSA 25. Catch in numbers by age (thousands).

Maturity at age data was based on the information given in Charilaou (2011) (Tab. 4.2.14.6.3.2) and natural mortality at age was calculated with the PRODBIOM method (Abella et al, 1997) (Tab. 4.2.14.6.3.3). Weight at age information for catches was also available in the official data for the years 2005-2013 (Tab. 4.2.14.6.3.4).

Tab. 4.2.14.6.3.2. Red mullet in GSA 25. Maturity at age.

		Age					
		0	1	2	3	4	5+
Year	2005	0.09	0.72	0.93	0.98	0.99	1
	2006	0.09	0.72	0.93	0.98	0.99	1
	2007	0.09	0.72	0.93	0.98	0.99	1
	2008	0.09	0.72	0.93	0.98	0.99	1
	2009	0.09	0.72	0.93	0.98	0.99	1
	2010	0.09	0.72	0.93	0.98	0.99	1
	2011	0.09	0.72	0.93	0.98	0.99	1
	2012	0.09	0.72	0.93	0.98	0.99	1
	2013	0.09	0.72	0.93	0.98	0.99	1

Tab. 4.2.14.6.3.3. Red mullet in GSA 25. Natural mortality at age.

		Age					
		0	1	2	3	4	5+
Year	2005	0.58	0.39	0.32	0.28	0.26	0.25
	2006	0.58	0.39	0.32	0.28	0.26	0.25
	2007	0.58	0.39	0.32	0.28	0.26	0.25
	2008	0.58	0.39	0.32	0.28	0.26	0.25
	2009	0.58	0.39	0.32	0.28	0.26	0.25
	2010	0.58	0.39	0.32	0.28	0.26	0.25
	2011	0.58	0.39	0.32	0.28	0.26	0.25
	2012	0.58	0.39	0.32	0.28	0.26	0.25
	2013	0.58	0.39	0.32	0.28	0.26	0.25

Tab. 4.2.14.6.3.4. Red mullet in GSA 25. Weight at age.

		Age					
		0	1	2	3	4	5+
Year	2005	0.009	0.020	0.029	0.041	0.055	0.101
	2006	0.010	0.021	0.030	0.044	0.063	0.091
	2007	0.010	0.020	0.030	0.045	0.063	0.088
	2008	0.010	0.020	0.030	0.044	0.062	0.100
	2009	0.010	0.020	0.028	0.043	0.060	0.097
	2010	0.010	0.020	0.031	0.044	0.061	0.087
	2011	0.014	0.027	0.042	0.069	0.097	0.145
	2012	0.014	0.029	0.044	0.068	0.097	0.158
	2013	0.013	0.029	0.044	0.069	0.099	0.153

The reference age chosen to run the separable VPA is the one most represented in the catch (age 1).

A sensitivity analysis on the results with $F_{terminal}$ values 0.10, 0.25 and 0.73 has been performed. It is noted that the value of M in oldest ages (0.25) was used as $F_{terminal}$, while the value of 0.73 derived from performing VPA-pseudocohort analysis with VIT software on 2010 data (Charilaou, 2011).

4.2.14.6.4 Results

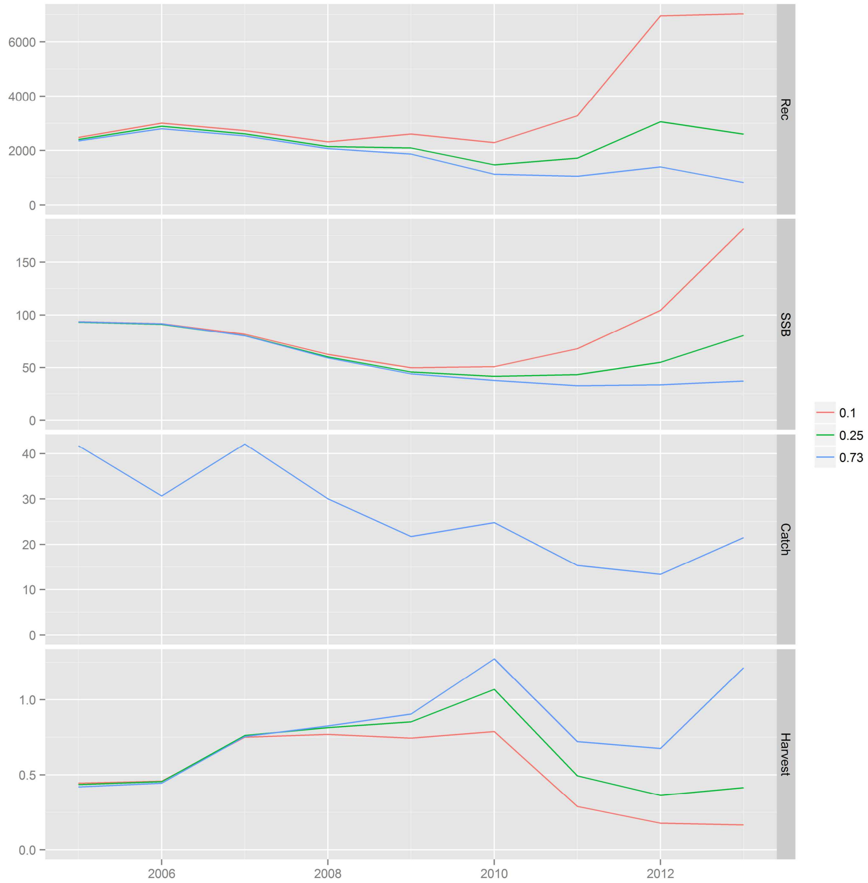

Fig. 4.2.14.6.4.1. Red mullet in GSA 25. Sensitivity of recruitment, SSB and F_{bar} with $F_{terminal}$ of 0.10 (red), 0.25 (green) and 0.73 (blue).

$F_{0.1}$ (as a proxy for F_{MSY}) = 0.303 was estimated based on the model results with the $F_{terminal}$ value of 0.10 and 0.75, while $F_{0.1}$ = 0.302 was estimated based on the model results with the $F_{terminal}$ value of 0.25.

4.2.14.7 Short term prediction

As the assessment is only indicative of trend for SSB and R, EWG 14-09 was not able to provide a short term forecast for this stock.

4.2.14.8 Data quality

With regards to fishing effort, data submitted Cyprus in response to the EU fisheries Data Collection Framework (DCF) data-call in 2014 only contained information on the total number of vessels using trammel nets; no nominal effort data or data in terms of vessel GT * days at sea was available. No information on the total number of vessels using trammel

nets was available for 2013. No nominal fishing effort data for bottom otter trawlers was available for 2013.
The Cypriot MEDITS data could not be used to generate a tuning file and partly due to changes in the exact timing of the survey (e.g. the survey was carried out in August in 2005, sampling more juveniles, and in June/July in 2006-2013).

4.2.14.9 Scientific advice

Since there is no current value of F, EWG 14-09 is unable to evaluate the status of the stock.

4.2.14.10 Short term considerations

4.2.14.10.1 State of the stock size

The results of the separable VPA showed a slight increase in spawning stock biomass from 2010 to 2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-09 is unable to evaluate the status of the stock spawning biomass in respect to these.

4.2.14.10.2 State of recruitment

Due to the lack of information from the MEDITS survey data regarding the juveniles of red mullet in GSA 25, it was not possible to evaluate the state of recruitment. However, the separable VPA showed a slight decrease of recruitment in 2013.

4.2.14.10.3 State of exploitation

Since there is no current value of F, EWG 14-09 is unable to evaluate the status of the exploitation in respect to this. However, there is a remarkable decrease of F since 2010.

4.2.14.11 Management recommendations

Since the assessment is only indicative of trend for SSB and R, the state of the stock cannot be defined and thus EWG 14-09 was not able to provide management recommendations.

4.2.15 STOCK ASSESSMENT OF STRIPED RED MULLET IN GSA 25

4.2.15.1 Stock Identification

Striped red mullet (*Mullus surmuletus*) is an important demersal target species for the artisanal fleet in Cyprus (GSA 25), where this species is mostly found on the continental shelf up to depths of 200 m; the highest concentration of individuals is usually found in the 0-150 m depth range. Striped red mullet generally inhabits mixed sediment as well as rocky and detritic bottoms, with a preference for patchy habitats made up of sand, rocks, coralligenous benthic communities. In coastal areas the species is often found in *Posidonia oceanica* seagrass meadows.

Due to a lack of information about the structure of the striped red mullet population in the eastern Mediterranean, this stock was assumed to be confined within the boundary of GSA 25 (Figure 4.2.15.1.1).

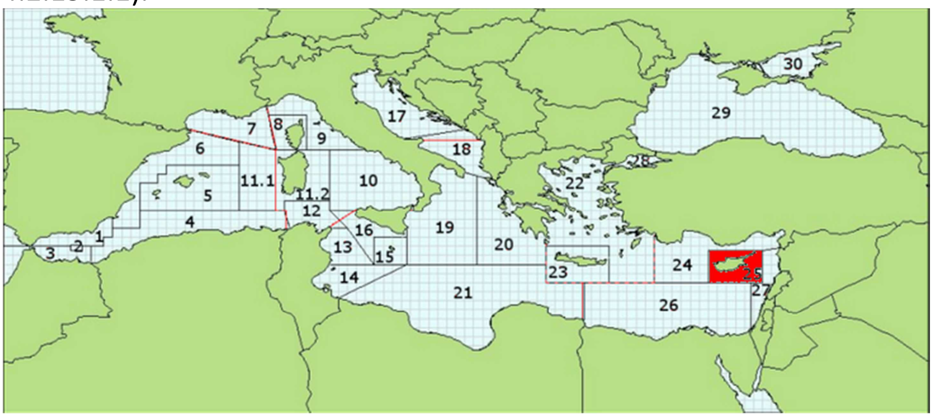

Figure 4.2.15.1.1. Geographical location of GSA 25.

4.2.15.2 Growth

Striped red mullet growth parameters which have been estimated based on otolith readings in several areas of the Mediterranean Sea, including in the Balearic Islands (GSA 5), the Ligurian and North Tyrrhenian Sea (GSA 9) and the Strait of Sicily (GSA 16), are summarised in Table 4.2.15.2.1 below.

Tab. 4.2.15.2.1. Striped red mullet in GSA 25. Von Bertalanffy growth function estimates and length-weight parameters in the Mediterranean; L_{inf}, k and t_0 refer to the asymptotic total length (cm), the curvature coefficient ($year^{-1}$) and the theoretical age at size 0 respectively.

Author	Area	Method	Sex	L∞	k	t_0	a	b
Andaloro and Giarritta (1985)	GSA 16	Otolith readings	F	29.75	0.49	-0.31	0.0093	3.07
			M	26.25	0.41	-0.23		
Renones (1995)	GSA 5	Otolith readings	M&F	31.28	0.211	-2.348	-	-
Machias et al. (1998)	GSA 23	Scale annuli readings &	M&F	35.4	0.225	-1.194	-	-

		LFD analysis						
Voliani et al. (1998)	GSA 9	LFD analysis	M&F	26.4	0.69	-0.47	0.0084	3.118
Ragonese et al. (2002)	GSA 16	Otolith readings & LFD analysis	F	29.0	0.48	-0.84	0.0195 - 0.0093	2.90 - 3.04
			M	25.0	0.5	-0.2	0.01758 - 0.007097	2.94 - 3.11
STECF EWG 11-12 (2012)	GSA 9	Otolith readings	F	32.0	0.44	-0.8	-	-
			M	28.0	0.44	-0.9	-	-
			M&F	32.0	0.43	-0.7	0.01	3.103
Charilaou C. (2011)	GSA 25	Otolith readings	M&F	45	0.1268	-1.08	0.01064	3.049
Guijarro et al. (2012)	GSA 5	Otolith readings	M&F	40.05	0.164	-1.883	0.0084	3.118

4.2.15.3 Maturity

The period of reproductive activity of striped red mullet is in spring until early summer (March-June), with subsequent recruitment taking place in summer. Length at maturity has been estimated at 13.8 cm for males and females combined within the framework of the Cyprus National Fisheries Data Collection Programme (Charilaou, 2011).

4.2.15.4 Fisheries

4.2.15.4.1 General description of Fisheries

Striped red mullet is mainly fished by the artisanal fleet using set nets (in particular trammel nets), and by bottom otter trawlers in GSA 25. In the trammel net fishery the species is harvested together with several other demersal species: *Sparisoma cretense*, *Octopus vulgaris*, *Sepia officinalis*, *Serranus cabrilla*, *Scorpaena* spp., Labridae, *Diplodus* spp., *Boops boops*, *Pagellus erythrinus*, and *Siganus* spp. Similarly bottom otter trawlers catch striped red mullet together with several accompanying species: *Spicara smaris*, *Boops boops*, *Mullus surmuletus*, *Pagellus erythrinus*, *Octopus vulgaris*, *Loligo vulgaris*, *Sepia officinalis*, *Eledone moschata*, *Octopus macropus*, *Pagellus acarne*, *Serranus cabrilla*, *Synodus saurus*, *Scorpaena* spp., *Trigloporus lastovisa*, *Uranoscopus scaber*, *Pagrus pagrus*, and *Merluccius merluccius* (Charilaou, 2011).

On average 93% of total striped red mullet landings in GSA 25 came from small scale vessels measuring up to a maximum length overall (LOA) of 12 m using trammel nets (gear code GTR) in 2005-2013. The remaining catches come from bottom otter trawlers.

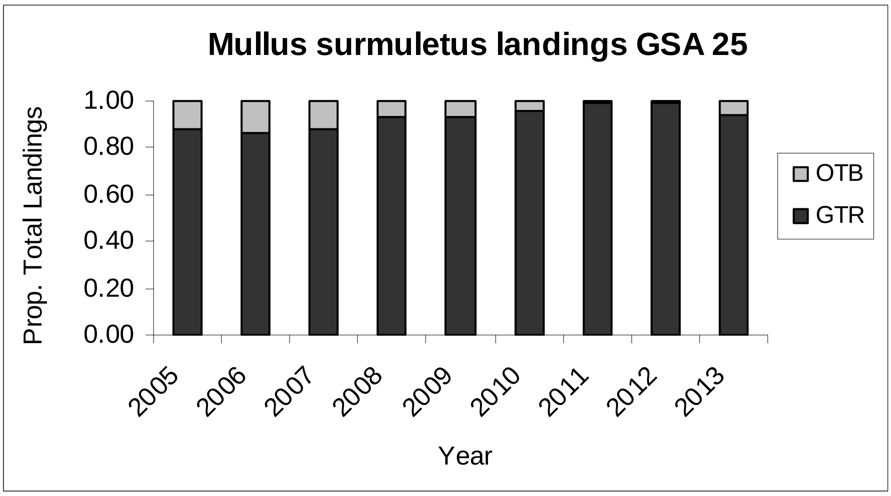

Figure 4.2.15.4.1.1. Striped red mullet in GSA 25. Proportion of total landings coming from vessels using bottom otter trawl (OTB) gear and from vessels using trammel nets (GTR)

4.2.15.4.2 Management regulations

The minimum landing size for red mullets (*Mullus* spp.) is 11 cm in European legislation (EC 1967/2006).

Charilaou (2011) provides the following information on regulations in force and degree of observance of regulations for artisanal vessels fishing striped red mullet in GSA 25:

1. Restriction of the maximum number of licenses (fully observed):

- Since 2008 assignment of licensed fishermen in 3 categories (A, B, C), based on their fishing activity and certain criteria.
- Licenses A&B restricted to 500.

2. Restrictions on the use of fishing gears depending on the fishing license category (fully observed).

- For licenses A & B: until March 2011 minimum mesh size of nets at 32mm (open mesh size): fully observed.
- From March 2011 minimum mesh size of nets at 38mm

3. Maximum length of nets (fully observed):

- For boats with license A is 5000m, for boats with license B is 3000m.
- Maximum height of nets: 4m.

4. Restrictions on the time and duration of fishing (fully observed):

- Depending on mesh sizes

5. For licenses C (not fully observed):

- Minimum mesh size of nets at 36mm (open mesh size).
- Prohibition of the use of monofilament nets.

- Maximum length of nets: 600 m.
- Restriction of number of fishing days at 70 days annually, during weekends of certain months.

Charilaou (2011) provides the following information on regulations in force and degree of observance of regulations for bottom otter trawlers fishing striped red mullet in GSA 25:

- From 2006 maximum number of licenses restricted to 4; from 2011 to 2: fully observed.
- Closed trawling period from 1st of June until the 7th of November (in force since the mid '80s): fully observed.
- From June 2010 the 40mm diamond shape trawl net replaced by a diamond meshed net of 50mm at the cod-end. From November 2011 minimum mesh size of 50mm diamond in any part of the net. Fully observed.
- Prohibition of bottom trawling at depths less than 50m and at distances less than 0.7 nautical miles off the coast. Fully observed.
- Prohibiton of bottom trawling in the Zygi coastal area, at a distance of 3 nautical miles from the coast. Fully observed.

4.2.15.4.3 Catches

4.2.15.4.4 Landings

Total striped red mullet landings in the period 2005-2013 decreased from 70.31 tonnes in 2005 to 21.78 tonnes in 2013; landings recorded in 2013 were at the lowest level recorded in the time series. The decrease in catches was observed both for vessels using trammel nets (from 62 tonnes in 2005 to 21 tonnes in 2013) and for vessels using bottom otter trawlers (from 8.5 tonnes in 2005 to 1.2 tonnes in 2013). For trawlers a slight increase in landings was observed in 2013 (1.20 tonnes) compared to 2011 (0.25 tonnes) and 2012 (0.28 tonnes).

Tab. 4.2.15.4.4.1. Striped red mullet GSA 25. Total annual landings (t) in 2005-2013 for GSA 25 as reported through the EU DCF data call.

	2005	2006	2007	2008	2009	2010	2011	2012	2013
GTR	61.79	46.04	29.14	51.66	39.35	37.51	25.16	27.85	20.57
OTB	8.52	7.10	4.01	3.87	3.04	1.62	0.25	0.28	1.21
Total	70.31	53.14	33.14	55.53	42.38	39.12	25.40	28.13	21.78

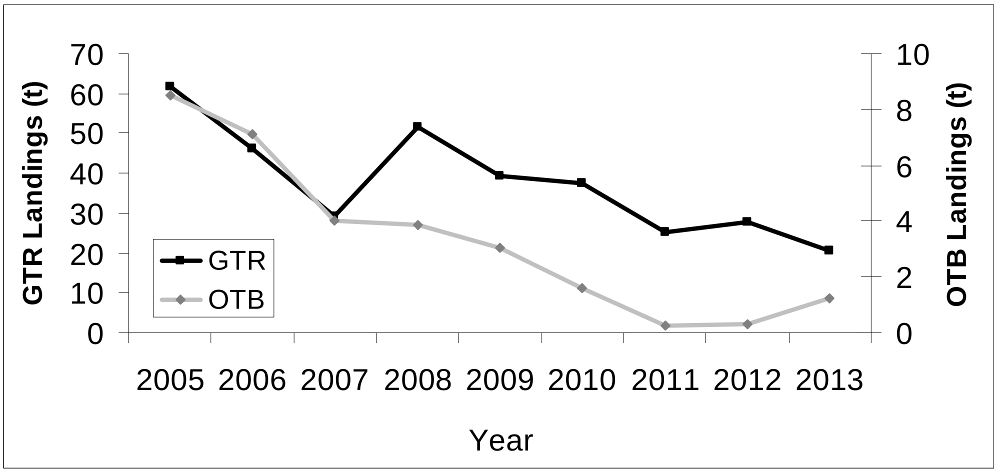

Figure 4.2.15.4.4.1. Striped red mullet in GSA 25. Total landings in 2005-2013.

Length frequencies of total landings from the Cypriot fleet are shown in Figure 4.2.15.4.4.2 below. Landings are dominated by specimens between 12-18 cm length.

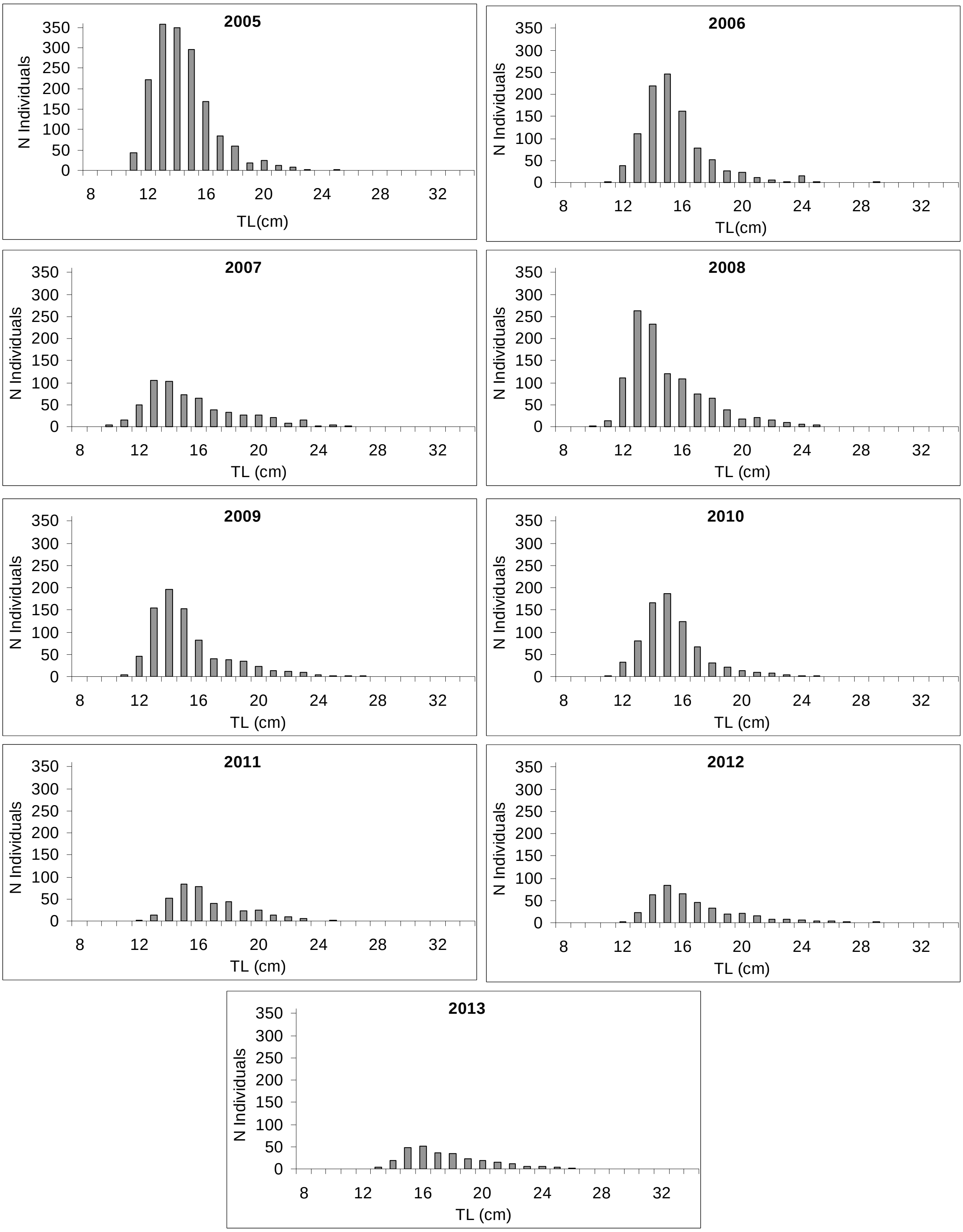

Fig. 4.2.15.4.4.2. Striped red mullet in GSA 25. Length frequency of landings in 2005-2013; numbers are in thousands.

4.2.15.4.5 Discards

No information on discards was available in the official data submitted by Cyprus in response to the DCF data call.

This is due to fact that a pilot study on the evaluation of discards in Cypriot fisheries, which was carried out as part of Cyprus' National Fisheries Data Collection Programme in 2006, showed that discards of this species by both bottom otter trawlers and vessels using trammel nets are negligible (Charilaou, 2011 and references therein).

4.2.15.4.6 Fishing Effort

With regards to fishing effort, data submitted Cyprus in response to the EU fisheries Data Collection Framework (DCF) data-call in 2014 only contained information on the total number of vessels using trammel nets; no nominal effort data or data in terms of vessel GT * days at sea was available. There was a 10% increase in the total number of artisanal vessels measuring 6-12 m LOA in 2005-2013 (2005: 390 vessels; 2013: 432 vessels). The number of artisanal vessels measuring 0-6 m LOA remained constant (2005: 40 vessels; 2013: 41 vessels).

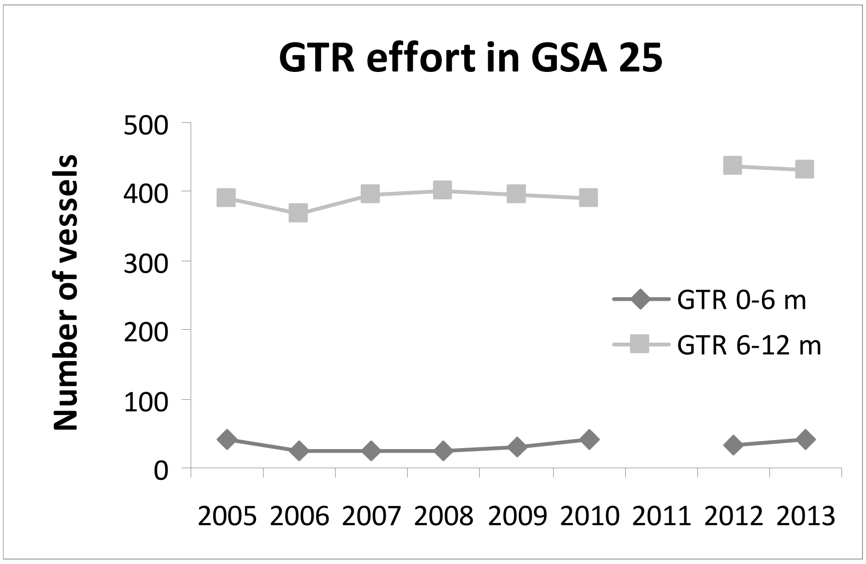

Fig. 4.2.15.4.6.1. Striped red mullet in GSA 25. Number of vessels in the 0-6 m and 6-12 m LOA fleet segments using trammel nets during 2005-2013.

With regards to vessels fishing with bottom otter trawlers, DCF data show a 64% decline in nominal fishing effort for Cypriot bottom otter trawlers in 2005-2012. No nominal fishing effort data for bottom otter trawlers was available for 2013.

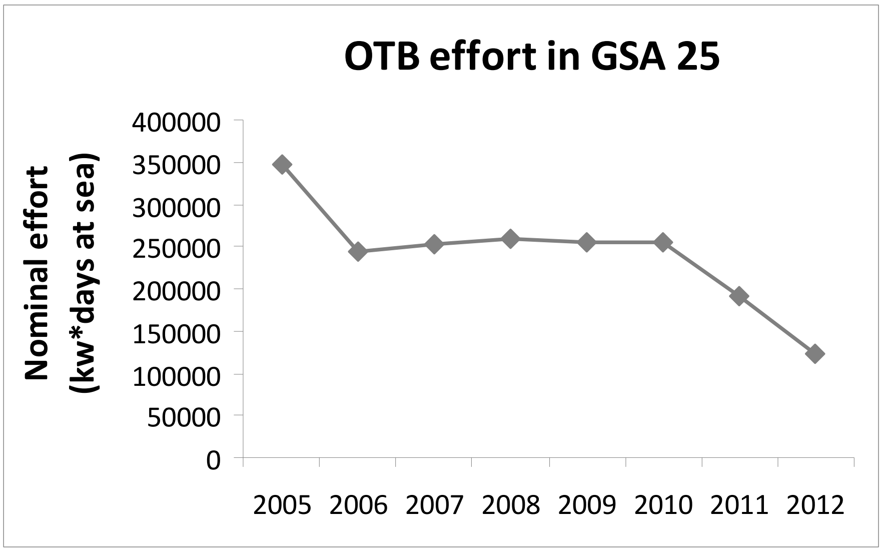

Fig. 4.2.15.4.6.2. Striped red mullet in GSA 25. Nominal effort (kW*days at sea) trend of Cypriot bottom otter trawler vessels (OTB) operating during 2005-2012.

Charilaou (2011) report a declining trend in landings per unit effort (LPUE in kg/day) for the artisanal fleet using trammel nets 2003-2008, and a stable trend thereafter. Regarding the bottom otter trawl fisheries the highest values of LPUE were in 1993-1994 and 2004; after 2006 a decreasing trend is evident, with the lowest values of the period 1985-2010 recorded in 2009 and 2010.

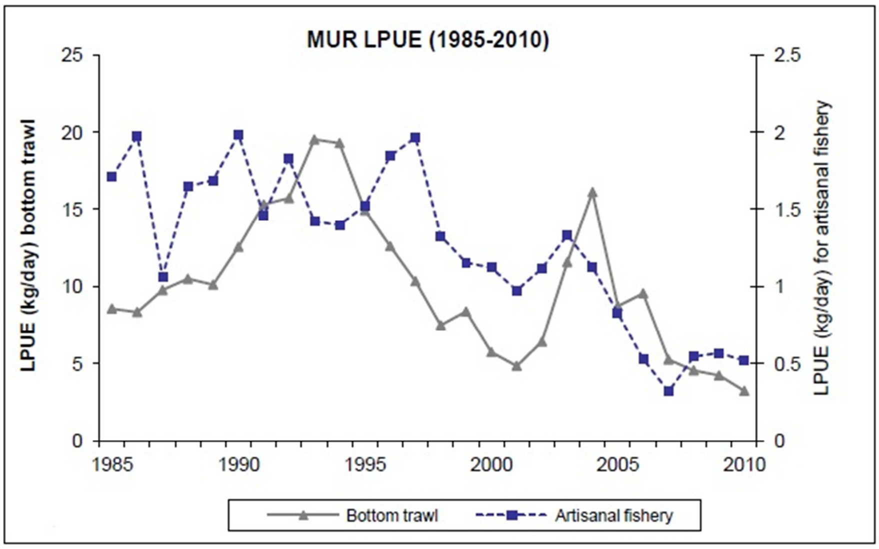

Fig. 4.2.15.4.6.3. Striped red mullet in GSA 25. Landings per unit effort (kg/day) for bottom otter trawlers (left axis) and artisanal vessels using trammel nets (right axis) during 1985-2010. *Source:* Charilaou (2011).

4.2.15.5 Scientific surveys: MEDITS

4.2.15.5.1 Methods

In order to collect fisheries independent data, which is a requirement of the EU DCF (Council Regulation 199/2008, Commission Regulation 665/2008, Commission Decision EC 949/2008 and Commission Decision 93/2010); the MEDITS international trawl survey is carried out in GSA 25 on an annual basis. The number of hauls carried out per depth stratum in 2005-2013 is reported below.

Tab. 4.2.15.5.1.1. Number of hauls per year and depth stratum in GSA 25, 2005-2013.

Depth (m)	2005	2006	2007	2008	2009	2010	2011	2012	2013
10-50	5	5	5	5	4	5	5	5	5
50-100	8	8	8	9	10	9	9	9	8
100-200	5	5	5	5	5	5	5	5	5
200-500	3	3	3	3	3	3	3	3	3
500-800	4	4	4	5	5	5	4	4	4
Total	**25**	**25**	**25**	**27**	**27**	**27**	**26**	**26**	**25**

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). A limited number of obvious data errors were corrected and catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches of hake, red mullet or pink shrimp (i.e. zero catches were included).

The abundance and biomass indices were subsequently calculated by stratified means (Cochran, 1953; Saville, 1977). This implies weighing average values of the individual standardized catches as well as the variation of each stratum by the respective stratum area:

$$Yst = \Sigma (Yi*Ai) / A \qquad V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A = total survey area
Ai = area of the i-th stratum
si = standard deviation of the i-th stratum
ni = number of valid hauls of the i-th stratum
n = number of hauls in the GSA
Yi = mean of the i-th stratum
Yst = stratified mean abundance
V(Yst) = variance of the stratified mean

The variation of the stratified mean is then expressed as the standard deviation.

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

4.2.15.5.2 Geographical distribution

Both reproduction and nursery areas are located on the continental shelf (Charilaou, 2011); however there is no information on the precise information on geographical distribution patterns of striped red mullet in GSA 25.

Due the preference of striped red mullet for coastal habitats and rocky bottoms, trawl survey cannot appropriately sample the species. Moreover since the MEDITS survey is carried out before the recruitment period of this species (summer-autumn), the MEDITS data cannot be used to identify nursery grounds.

As a consequence the recently completed MAREA-MEDISEH project concluded that in GSA 25 the identification of nursery and spawning areas through modelling approaches was not possible due in general to the few Medits positive hauls in each annual survey and their relatively high distance, which did not allow for the implementation of any reasonable model denying the estimate of spatial covariance.

4.2.15.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of the striped red mullet stock in GSA 25 can be derived from the international bottom trawl survey MEDITS, which has been carried out in GSA 25 since 2005. MEDITS data was standardised using the routine developed by Facchini et al. (2013).

MEDITS indices calculated for the period 2005-2013 show highest values of numbers of striped red mullet in 2005 (122 individuals per km^2) and 2013 (61 individuals per km^2), with lower values (average 8 individuals per km^2) in the years in 2006-2012.

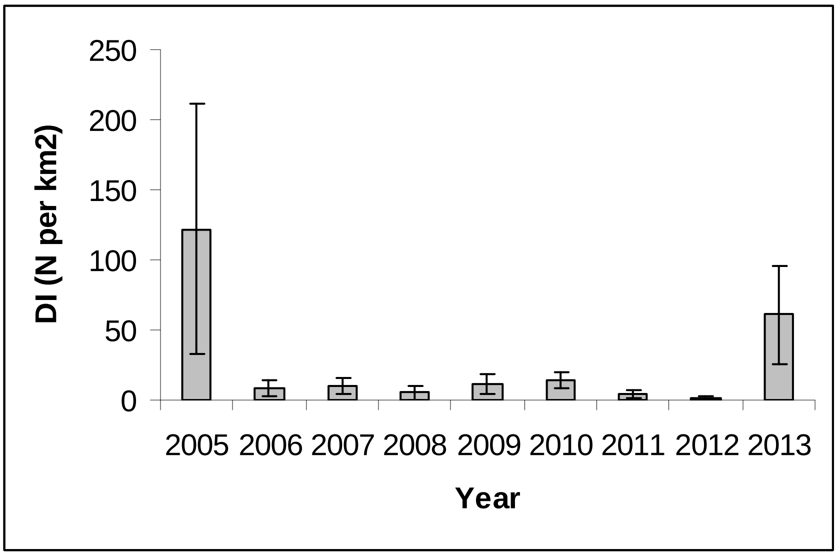

Fig. 4.2.15.5.3.1. Striped red mullet in GSA 25. Abundance MEDITS indices for the years 2005-2013.

Biomass indices during the same period showed a decline from 2005 (1.2 kg per km^2) to 2012 (0.2 kg per km^2), with a peak in 2013 (4 kg per km^2).

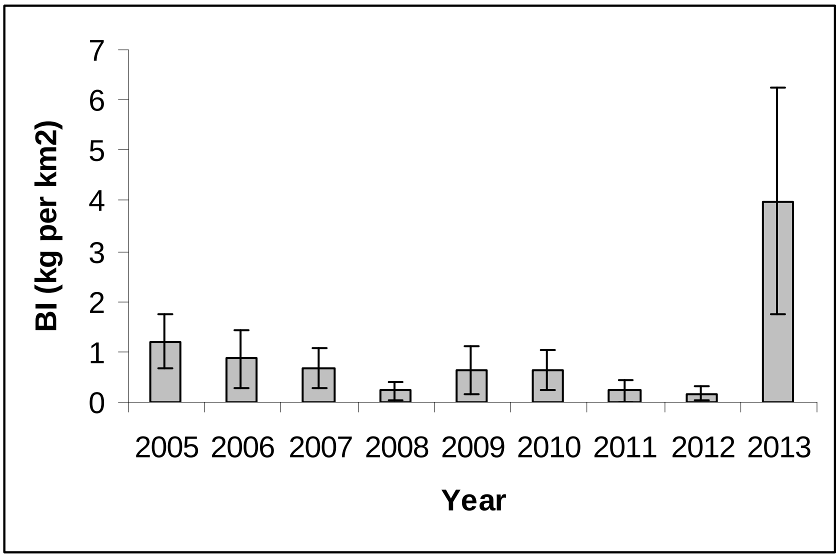

Fig. 4.2.15.5.3.2. Striped red mullet in GSA 25. Biomass indices for the years 2005-2013.

4.2.15.5.4 Trends in abundance by length or age

The following Figure 4.2.15.5.4.1 displays the stratified abundance indices (striped red mullet in GSA 25 in 2005-2013). The abundance indices varied considerably between years, which is likely to be due the preference of striped red mullet for coastal habitats and rocky bottoms. Such habitats can not be appropriately sampled by trawl survey. In 2005 the survey was carried out in August, whilst normally the survey takes place in June/July. This is likely to be the reason for the observed high number of juveniles in 2005.

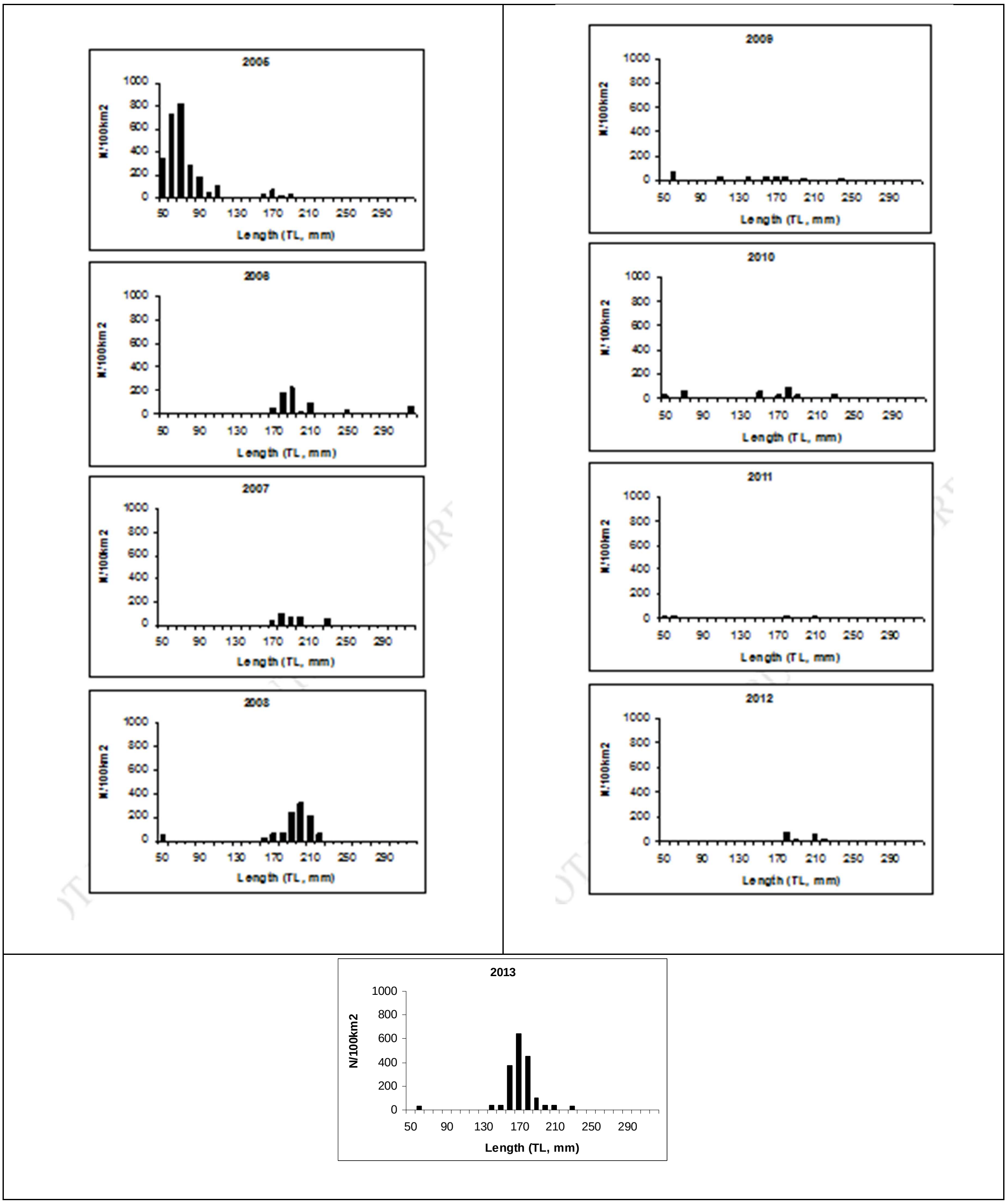

Fig. 4.2.15.5.4.1. Striped red mullet in GSA 25. Stratified abundance indices by size class, 2005-2013.

The stratified abundance indices by size were nevertheless converted into numbers at age using the knife edge age slicing routine developed by Jardim et al. (2014) and the von Bertalanffy growth function estimates given in Charilaou (2011). The obtained results are detailed in Table 4.2.15.5.4.2 below.

Tab. 4.2.15.5.4.2. Striped red mullet GSA 25. MEDITS abundance indices by age class, 2005-2013.

		Year								
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Age	**0**	23.6	0	0	0.5	0.6	0.8	0.5	0	0.3
	1	1570.0	0	0	0	0.7	0	0	0	0.4
	2	1039.0	0.4	0.3	0.9	0.7	0.8	0	0	10532.0
	3	0.6	4115.0	2416.0	6321.0	0.5	1097.0	0.3	0.9	5842.0
	4	0	0.9	0.6	2740.0	0	0.3	0.3	0.7	0.7
	5	0	0.3	0	0	0.1	0	0	0	0
	6	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0
	9	0	0.6	0	0	0	0	0	0	0

4.2.15.5.5 Trends in growth

No specific analyses were conducted during EWG 14-09.

4.2.15.5.6 Trends in maturity

No specific analyses were conducted during EWG 14-09.

4.2.15.6 Assessment of historic stock parameters

4.2.15.6.1 Method1: Separable VPA

4.2.15.6.2 Justification

Due to the lack of reliable information from MEDITS survey data and the lack of effort data for the main fleet segment targeting striped red mullet in GSA 25, EWG 14-09 applied a separable VPA method to evaluate the status of this stock.

4.2.15.6.3 Input parameters

For the assessment of the striped red mullet stock in GSA 25 official DCF data of commercial catches were used. The analysis was carried out using sex combined data.

The annual size distributions of GSA 25 catches were converted into numbers at age using the knife edge age slicing routine developed by Jardim et al. (2014) and the von Bertalanffy growth function estimates given in Charilaou (2011); the results are shown in Tab. 4.2.15.6.3.1 and Fig. 4.2.15.6.3.1.

Tab. 4.2.15.6.3.1. Striped red mullet in GSA 25. Catch in numbers by age (thousands).

		Age				
		1	**2**	**3**	**4**	**5+**
Year	**2005**	971.53	550.61	101.52	23.09	2.27
	2006	371.21	484.00	101.16	18.37	19.99
	2007	275.30	174.18	84.19	43.24	6.69
	2008	619.87	302.96	119.75	44.80	14.32
	2009	400.79	274.11	95.11	33.17	7.91
	2010	279.13	376.79	65.19	22.06	6.06
	2011	66.06	201.89	91.38	27.15	2.69
	2012	88.76	192.08	72.96	31.14	17.08
	2013	22.99	133.87	75.53	30.74	10.27

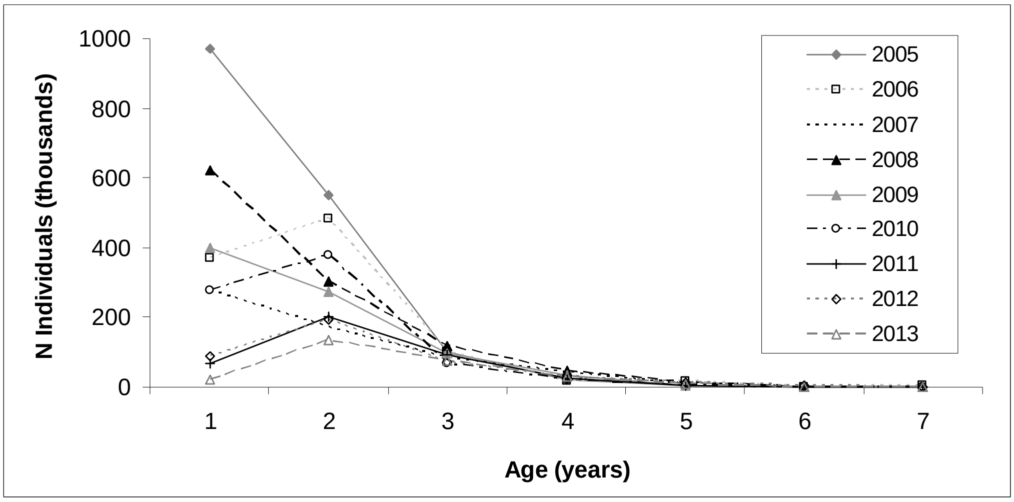

Fig. 4.2.15.6.3.1. Striped red mullet in GSA 25. Catch in numbers by age (thousands).

Maturity at age data was based on the information given in Charilaou (2011) and natural mortality at age was calculated with the PRODBIOM method.

Tab. 4.2.15.6.3.2. Striped red mullet in GSA 25. Maturity at age.

		Age				
		1	**2**	**3**	**4**	**5+**
Year	**2005**	0.34	0.69	0.9	0.97	1
	2006	0.34	0.69	0.9	0.97	1
	2007	0.34	0.69	0.9	0.97	1
	2008	0.34	0.69	0.9	0.97	1
	2009	0.34	0.69	0.9	0.97	1
	2010	0.34	0.69	0.9	0.97	1
	2011	0.34	0.69	0.9	0.97	1
	2012	0.34	0.69	0.9	0.97	1
	2013	0.34	0.69	0.9	0.97	1

Tab. 4.2.15.6.3.3. Striped red mullet in GSA 25. Natural mortality at age.

		Age				
		1	**2**	**3**	**4**	**5+**
Year	**2005**	0.35	0.2	0.15	0.13	0.11
	2006	0.35	0.2	0.15	0.13	0.11
	2007	0.35	0.2	0.15	0.13	0.11
	2008	0.35	0.2	0.15	0.13	0.11
	2009	0.35	0.2	0.15	0.13	0.11
	2010	0.35	0.2	0.15	0.13	0.11
	2011	0.35	0.2	0.15	0.13	0.11
	2012	0.35	0.2	0.15	0.13	0.11
	2013	0.35	0.2	0.15	0.13	0.11

Weight at age information for catches was available in the official data for the years 2005-2010 but not for the years 2011-2013. As a consequence actual weight at age data for each year could not be used and an average weight at age was calculated based on the years where the data was available.

Tab. 4.2.15.6.3.4. Striped red mullet in GSA 25. Weight at age.

		Age				
		1	2	3	4	5+
Year	2005	0.028	0.046	0.075	0.112	0.181
	2006	0.028	0.046	0.075	0.112	0.181
	2007	0.028	0.046	0.075	0.112	0.181
	2008	0.028	0.046	0.075	0.112	0.181
	2009	0.028	0.046	0.075	0.112	0.181
	2010	0.028	0.046	0.075	0.112	0.181
	2011	0.028	0.046	0.075	0.112	0.181
	2012	0.028	0.046	0.075	0.112	0.181
	2013	0.028	0.046	0.075	0.112	0.181

The reference age chosen to run the separable VPA is the one most represented in the catch (age 1).

A sensitivity analysis on the results with $F_{terminal}$ values 0.06, 0.12 and 0.18 has been performed.

4.2.15.6.4 Results

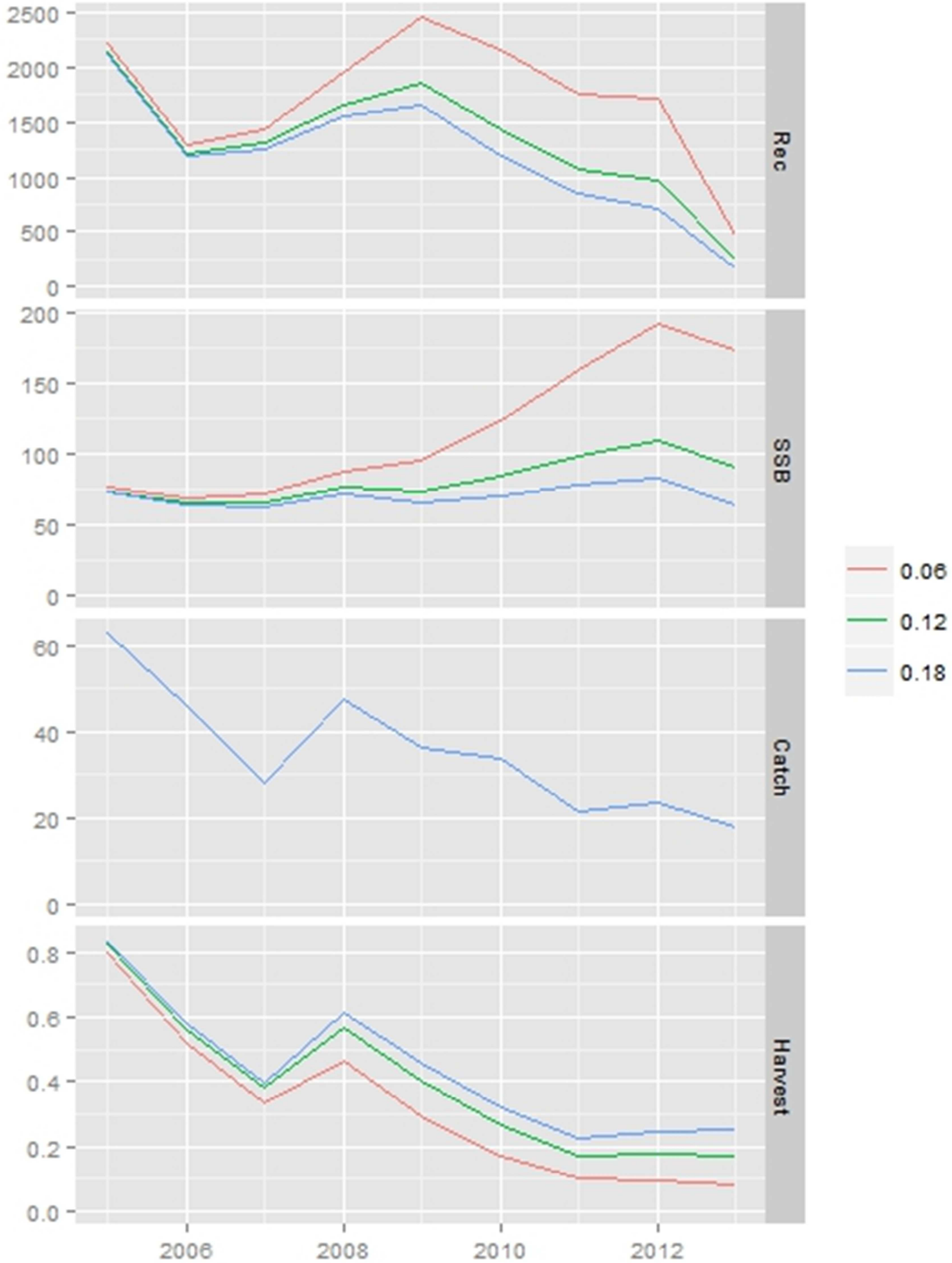

Fig. 4.2.15.6.4.1 Striped red mullet in GSA 25. Sensitivity of recruitment, SSB and F_{bar} with $F_{terminal}$ of 0.06 (red), 0.12 (green) and 0.18 (blue).

$F_{0.1}$ (as a proxy for F_{MSY}) = 0.141 was estimated based on the model results with the $F_{terminal}$ value of 0.06 and 0.12; $F_{0.1}$ = 0.142 based on the model results with the $F_{terminal}$ value of 0.18. The model with the $F_{terminal}$ value of 0.12 was considered to result in the best fit. F_{curr} = 0.17 was calculated based on the geometric mean of the years 2011-2013 for the best fit model ($F_{terminal}$ = 0.12).

Short term prediction

As the assessment is only indicative of trend for SSB and R, EWG 14-09 was not able to provide a short term forecast for this stock.

4.2.15.8 Data quality

Medits data was only available as raw data (TA, TB, TC files). Standardised indices (i.e. standardised abundance (n/km2) and biomass (kg/km2) indices) should be made available to experts at the beginning of the meeting to facilitate the work in future years.

No data on biological parameters (e.g. maturity data) was available to experts at the meeting since the data call does not ask for such information although it is collected by Member States.

With regards to fishing effort, data submitted Cyprus in response to the EU fisheries Data Collection Framework (DCF) data-call in 2014 only contained information on the total number of vessels using trammel nets; no nominal effort data or data in terms of vessel GT * days at sea was available. No information on the the total number of vessels using trammel nets was available for 2013. No nominal fishing effort data for bottom otter trawlers was available for 2013.

Commercial landings data in terms of numbers at age and weight at age were available in the official Cypriot data for 2005-2010, but missing for the years 2011-2013.

The Cypriot MEDITS data could not be used to generate a tuning file. This was partly due to the fact that striped red mullet is found in coastal habitats and rocky bottoms (which can not be surveyed appropriately by using a trawl survey like MEDITS), and partly due to changes in the exact timing of the survey (e.g. the survey was carried out in August in 2005 - hence sampling more juveniles in 2005 - and in June/July in 2006-2013).

4.2.15.9 Scientific advice

Since the assessment is only indicative of trend, the state of the stock cannot be defined.

4.2.15.10 Short term considerations

4.2.15.10.1 State of the stock size

In the absence of proposed and agreed precautionary management references points, EWG 14-09 is unable to fully evaluate the status of the spawning stock biomass in respect to these. However the results of the separable VPA showed a slight increase in spawning stock biomass from 2009 to 2012, followed by a small decrease in 2013.

4.2.15.10.2 State of recruitment

Due to the lack of reliable information from MEDITS survey data for striped red mullet in GSA 25, it was not possible to evaluate the state of recruitment. However the separable VPA showed a sharp decrease of recruitment in recent years.

4.2.15.10.3 State of exploitation

4.2.15.11 Management recommendations

Since the assessment is only indicative of trend, the state of the stock cannot be defined and thus EWG 14-09 was not able to provide management recommendations.

5 ToR C) PROVIDE FOR EACH OF THE 15 PRIORITY STOCKS A SHORT TERM AND A MEDIUM TERM FORECAST

5.1 Short and medium term predictions for HAKE in GSA 6

5.1.1 Short term prediction 2014-2016

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC, based on the results of the XSA stock assessments performed during EWG 14-09 for the years 2002–2013.

5.1.1.1 Input parameters

The input parameters were the same used for the XSA stock assessment and its results.

5.1.1.2 Recruitment

Recruitment (class 0) has been estimated as the geometric mean of the last three years 2011-2013, taken from XSA results= 101200 (thousands).

5.1.2 Outlook until 2016

A short term projection table (Table 5.1.2.1) assuming a current F =1.48 in 2014 and a recruitment of 78 521 thousand individuals shows that:

Fishing at F_{curr} from 2014 to 2015 would produce an increase in catches of 17.6% and SSB would decrease by 6.2% between 2015 and 2016.
Fishing at F_{MSY} (0.147) from 2014 to 2015 would generate a decrease of 78.3% of the catches and an increase of 321% in SSB in 2016.
Catches of hake in 2015 consistent with F_{MSY} would not exceed 675 tonnes.

Table 5.1.2.1. Hake in GSA 6. Short term forecast in different F scenarios. Basis: F(2014)= 1.477; R(2014-2016)= 101199 (thousands); SSB(2013)= 1476 t; landings (2013)= 3119 t.

Rationale	Ffactor	Fbar	Catch_2015	Catch_2016	SSB_2016	Change_SSB_ 2015-2016(%)	Change_Catch_ 2013-2015(%)
zero catch	0	0	0	0	8720.9	404.7	-100
High long-term yield (F_{MSY})	0.10	0.147	675.5	1699.2	7276.3	321.1	-78.3
Status quo	1	1.477	3668.9	3566.9	1620.8	-6.2	17.6
Different scenarios	0.1	0.148	678.4	1705.2	7270.3	320.8	-78.3
	0.2	0.295	1252.2	2738.9	6073.4	251.5	-59.9
	0.3	0.443	1739.0	3336.3	5085.5	194.3	-44.2
	0.4	0.591	2153.4	3654.1	4269.8	147.1	-31.0
	0.5	0.738	2507.5	3795.8	3596.1	108.1	-19.6
	0.6	0.886	2811.3	3829.7	3039.2	75.9	-9.9
	0.7	1.034	3073.0	3800.1	2578.8	49.2	-1.5
	0.8	1.181	3299.5	3735.5	2197.8	27.2	5.8

	0.9	1.329	3496.6	3654.1	1882.3	8.9	12.1
	1.1	1.624	3820.4	3480.6	1403.8	-18.8	22.5
	1.2	1.772	3954.3	3398.9	1223.6	-29.2	26.8
	1.3	1.920	4073.4	3323.6	1073.7	-37.9	30.6
	1.4	2.067	4180.0	3255.4	948.7	-45.1	34.0
	1.5	2.215	4275.9	3194.3	844.5	-51.1	37.1
	1.6	2.363	4362.7	3139.9	757.3	-56.2	39.9
	1.7	2.510	4441.8	3091.7	684.1	-60.4	42.4
	1.8	2.658	4514.3	3049.0	622.6	-64.0	44.7
	1.9	2.806	4581.0	3011.1	570.7	-67.0	46.9
	2	2.953	4642.9	2977.3	526.7	-69.5	48.9

5.1.3 Short term implications

5.1.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessment performed during EWG 14-09.

5.1.4 Medium term implications

5.1.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship. (Fig. 5.1.4.1.1).

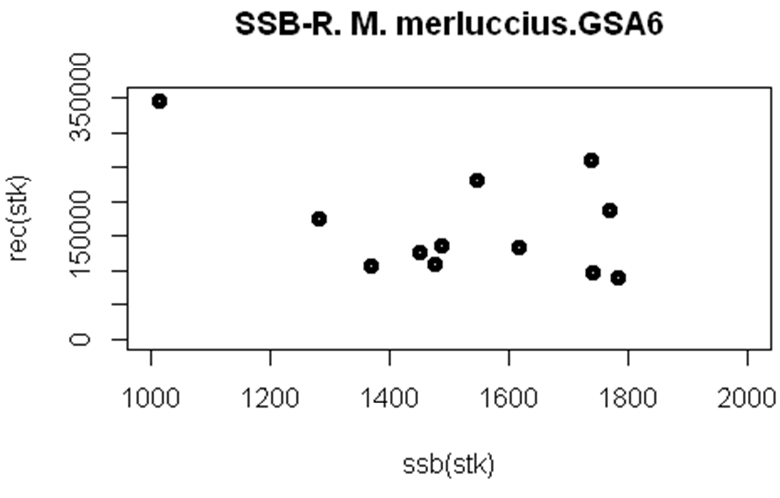

Fig. 5.1.4.1.1. Hake in GSA 6. Spawning stock biomass- recruitment relationship 2002-2013.

5.2 Short and medium term predictions for RED MULLET in GSA 6

5.2.1 Short term prediction

5.2.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using a FLR routine, which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed.

5.2.1.2 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age. Different scenarios of constant harvest strategy with F calculated as the average of ages 0 to 2 (F_{bar} ages 0-2) and F status quo (F_{curr} = 1.47) were performed. Recruitment (class 0) has been estimated as the geometric mean of the last three years 2011-2013 estimated with XSA.

5.2.1.3 Results

A short term projection (Table 5.2.2.1), assuming an F_{curr} of 1.47 in 2013 and a recruitment of 82550 thousands individuals, shows that:

Fishing at the F_{stq} (1.47) generates an increase of the catch of 4% from 2013 to 2015 along with a decrease of the spawning stock biomass of 1% from 2015 to 2016.
Fishing at F_{MSY} (0.15) generates a decrease of the catch of 79% from 2013 to 2015 and an increase of the spawning stock biomass of 75% from 2015 to 2016.
Catches of red mullet in 2015 consistent with F_{MSY} would not exceed 659 tonnes.

5.2.2 Outlook until 2016

Table 5.2.2.1. Red mullet in GSA 6. Short term forecast in different F scenarios.
Basis: F(2014) = mean(F_{bar}0-2 2011-2013)= 1.47; R(2014) = geometric mean of the recruitment of the last 3 years; R = 82550 (thousands); SSB(2013) = 2012 t, Catch (2013)= 1245 t.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	SSB 2016	Change SSB 2015-	Change Catch 2013-
zero catch	0.0	0.00	0.0	0.0	3700.8	95.8	-100.0
High long-term (F_{MSY})	0.3	0.45	659.1	1047.7	2727.7	44.3	-47.1
Status quo	1.0	1.47	1301.1	1290.9	1879.5	-0.6	4.5
Different scenarios	0.1	0.15	259.0	517.8	3311.5	75.2	-79.2
	0.2	0.29	472.7	840.7	2996.5	58.5	-62.0
	0.3	0.44	649.7	1038.8	2741.1	45.0	-47.8
	0.4	0.59	796.8	1157.7	2533.7	34.0	-36.0
	0.5	0.74	919.7	1226.6	2364.7	25.1	-26.1
	0.6	0.88	1022.8	1264.6	2226.7	17.8	-17.9
	0.7	1.03	1109.8	1283.7	2113.6	11.8	-10.9
	0.8	1.18	1183.7	1291.5	2020.5	6.9	-5.0
	0.9	1.32	1246.8	1292.9	1943.5	2.8	0.1
	1.1	1.62	1348.1	1287.2	1825.9	-3.4	8.3

	1.2	1.77	1389.2	1282.9	1780.7	-5.8	11.6
	1.3	1.91	1425.4	1278.6	1742.2	-7.8	14.5
	1.4	2.06	1457.6	1274.5	1709.3	-9.6	17.0
	1.5	2.21	1486.4	1270.9	1680.7	-11.1	19.4
	1.6	2.35	1512.3	1267.6	1655.8	-12.4	21.4
	1.7	2.50	1536.0	1264.9	1633.7	-13.6	23.3
	1.8	2.65	1557.6	1262.4	1614.0	-14.6	25.1
	1.9	2.80	1577.6	1260.3	1596.2	-15.6	26.7
	2.0	2.94	1596.2	1258.5	1579.9	-16.4	28.2

5.2.3 Short term implications

5.2.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessment performed during EWG 14-09.

5.2.4 Medium term implications

5.2.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.3 Short and medium term predictions for BLUE WHITING in GSA 6

5.3.1 Short term prediction 2014-2015

5.3.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using a FLR routine, which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed.

5.3.1.2 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age. Mortality at age was the same as used as input data in the XSA.

5.3.1.3 Recruitment

Recruitment (class 0+) in 2014 has been estimated as the geometric mean (2011-2013), taken from XSA results = 101838 (thousands).

5.3.2 Outlook until 2016

Table 5.3.2.1. GSA 6 blue whiting. Results for the short term analysis.

Basis F(2014)= 1.52; R(2014-2016)=101838 (thousands); SSB(2013)=341 t; landings(2013)=1022 t.

	F scenario	F factor	Catch 2015	Catch 2016	SSB 2016	Change SSB 2015-2016(%)	Change Catch 2013-2015(%)
zero catch	0	0	0	0	2047.92	404.84	-100
High long-term yield (F_{MSY})	0.16	0.11	257.56	584.48	1685.52	315.50	-74.77
Status quo	1.52	1.00	1291.62	1230.82	345.53	-14.82	26.54
Different scenarios	0.15	0.10	245.21	560.82	1702.74	319.75	-75.98
	0.30	0.20	451.34	900.21	1417.64	249.47	-55.78
	0.45	0.30	625.05	1097.90	1181.89	191.35	-38.77
	0.61	0.40	771.82	1206.03	986.74	143.24	-24.39
	0.76	0.50	896.18	1258.56	825.01	103.38	-12.20
	0.91	0.60	1001.85	1277.43	690.85	70.30	-1.85
	1.06	0.70	1091.89	1276.75	579.43	42.84	6.97
	1.21	0.80	1168.85	1265.41	486.80	20.00	14.51
	1.36	0.90	1234.85	1248.97	409.73	1.00	20.98
	1.67	1.10	1340.63	1212.92	292.00	-28.02	31.34
	1.82	1.20	1383.08	1196.34	247.34	-39.03	35.50
	1.97	1.30	1419.98	1181.63	210.04	-48.22	39.11

	2.12	1.40	1452.18	1168.96	178.86	-55.91	42.27
	2.27	1.50	1480.39	1158.31	152.77	-62.34	45.03
	2.43	1.60	1505.19	1149.57	130.93	-67.72	47.46
	2.58	1.70	1527.08	1142.55	112.63	-72.24	49.61
	2.73	1.80	1546.49	1137.05	97.29	-76.02	51.51
	2.88	1.90	1563.76	1132.87	84.41	-79.19	53.20
	3.03	2.00	1579.20	1129.81	73.60	-81.86	54.71

5.3.3 Short term implications

A short term projection table (Table 5.3.2.1) assuming a current F of 1.52 in 2014 and a recruitment of 101838 thousand individuals shows that:

Fishing at F_{stq} from 2013 to 2015 would produce an increase in catches of 27% and a decrease in SSB of 15% between 2015 and 2016.
Fishing at F_{MSY} (0.16) from 2013 to 2015 would generate a decrease of 75% of the catches and an increase of 315% in SSB between 2015 and 2016.
Catches of blue whiting in 2015 consistent with F_{MSY}=0.16 should exceed 258 t.

5.3.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessment performed during EWG 14-09.

5.3.4 Medium term implications

5.3.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.4 Short and medium term predictions for HAKE in GSA 7

5.4.1 Short term prediction 2014-2015

5.4.1.1 Method and justification

Short term predictions were run in R (www.r-project.org) using the FLR libraries (http://www.flr-project.org/) and the results of the a4a model (see section 3.2.5).

5.4.1.2 Input parameters

The input parameters were the same used for the a4a stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Table 5.4.1.2.1. Hake in GSA 7. F status quo, recruitment and catch used for the short-term forecast.

Parameter	Method	Value
F status quo	Average over ages 0-3 and 2011-2013	1.67
Recruitment (*)	Geometric mean of recruitment over 2011-2013	30224 thousands
Catch (2013)	Estimated by the model	1181 tons

Table 5.4.1.2.2. Hake in GSA 7. Input parameters at age for the short-term forecast

Age	F (2011-2013)	Weight in catch (2011-2013)	Number in the catch (2013)	Number in the Stock (2014)
0	0.273	0.039	2831	30224 (*)
1	1.306	0.112	6175	7075
2	2.238	0.270	1402	2650
3	2.974	0.705	64	238
4	2.801	1.484	3	6
5	0.819	1.755	0	0

5.4.2 Outlook until 2016

For the short-term forecast, all the fleets, Spanish and French bottom trawlers, Spanish longliners, French gillnetters, were combined.

Table 5.4.2.1. Hake in GSA 7. Short-term forecast in different F scenarios.

Ffactor	Fbar	Catch 2013	Catch 2014	Catch 2015	Catch 2016	SSB 2015	SSB 2016	Change SSB 2015-2016 %	Change Catch 2013 -2015 %
0.00	0.00	1181	1405	0	0	790	2420	206	-100
0.10	0.17	1181	1405	221	564	790	2101	166	-81
0.20	0.33	1181	1405	411	907	790	1838	133	-65
0.30	0.50	1181	1405	574	1111	790	1618	105	-51

0.40	0.67	1181	1405	715	1229	790	1435	82	-40
0.50	0.84	1181	1405	838	1291	790	1281	62	-29
0.60	1.00	1181	1405	945	1320	790	1151	46	-20
0.70	1.17	1181	1405	1040	1328	790	1040	32	-12
0.80	1.34	1181	1405	1124	1323	790	946	20	-5
0.90	1.50	1181	1405	1199	1311	790	866	10	2
1.00	1.67	1181	1405	1267	1295	790	796	1	7
1.10	1.84	1181	1405	1327	1277	790	736	-7	12
1.20	2.01	1181	1405	1382	1258	790	684	-13	17
1.30	2.17	1181	1405	1432	1239	790	639	-19	21
1.40	2.34	1181	1405	1477	1221	790	599	-24	25
1.50	2.51	1181	1405	1519	1204	790	564	-29	29
1.60	2.67	1181	1405	1557	1187	790	533	-33	32
1.70	2.84	1181	1405	1593	1172	790	506	-36	35
1.80	3.01	1181	1405	1626	1158	790	481	-39	38
1.90	3.18	1181	1405	1656	1145	790	459	-42	40
2.00	3.34	1181	1405	1685	1133	790	440	-44	43
F_{MSY}	0.17	1181	1405	230	581	790	2090	164	-81

5.4.3 Short term implications

The short term projection (Table 5.4.2.1), assuming an Fstq of 1.70 in 2013 and a recruitment of 31114 (thousands) individuals shows that:

Fishing at the F_{stq} (1.70) generates an increase in catch by 7% from 2013 to 2015 along with an increase in the spawning stock biomass of 1% from 2015 to 2016.
Fishing at F_{MSY} (0.17) generates a decrease in catch by 81 % from 2013 to 2015 and a spawning stock biomass increase by 164% from 2015 to 2016.
Catches of hake in 2015 consistent with F_{MSY} would not exceed 230 tonnes.

5.4.3.1 Method and justification

5.4.4 Medium term implications

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the a4a stock assessment performed during EWG 14-09

5.4.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.5 Short and medium term predictions for RED MULLET in GSA 7

5.5.1 Short term prediction 2014-2015

5.5.1.1 Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994).

5.5.1.2 Input parameters

The following data have been used to derive the input data for the short term projection of the red mullet stock in GSA 7:

Maturity at age

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.67	0.64	0.69	0.69	0.67	0.64	0.62	0.62	0.63	0.61
1	0.84	0.85	0.83	0.84	0.86	0.85	0.85	0.86	0.84	0.85
2	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.95	0.95
3	0.97	0.98	0.97	0.98	0.97	0.97	0.97	0.97	0.97	0.97
4	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Natural mortality at age

Age/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
1	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
2	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
3	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
4+	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

F vector

F	0	1	2	3	4
2011-2013	0.102	0.568	0.858	0.330	0.330

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	4+
2011-2013	0.014	0.029	0.057	0.077	0.115

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	4+
2011-2013	0.014	0.028	0.056	0.076	0.114

Number at age in the catch

Catch at age in numbers (*1000)	0	1	2	3	4+
2013	1045	5126	1618	370	23

Number at age in the stock

Stock at age in numbers (*1000)	0	1	2	3	4+
2014	35077*	22476	5382	1138	974

** Geometric mean of the recruitment estimated over the 2011-2013 period*

5.5.1.3 Recruitment

Recruitment (age 0) has been set equal to the geometric mean of the last three recruitments 2011-2013 estimated by XSA.

5.5.2 Outlook until 2015

5.5.3 Short term implications

A short term projection (Table 5.5.3.1), assuming an F_{stq} of 0.45 in 2013 and a recruitment of 35077 (thousands) individuals, shows that:

Fishing at the F_{stq} (0.45) generates an increase in the catch of 73% from 2013 to 2015 along with a decrease in the spawning stock biomass of 2% from 2015 to 2016.

Fishing at F_{MSY} (0.14) generates a decrease in the catch of 35% from 2013 to 2015 and an increase in the spawning stock biomass of 26% from 2015 to 2016.

Catches of red mullet in 2015 consistent with F_{MSY} would not exceed 195 tonnes.

Table 5.5.3.1. Red mullet in GSA 7. Short term forecast in different F scenarios. Basis: F(2014) = mean(F_{0-3} 2011-2013); R(2014) = mean recruitment of the last 3 years; R = 35077 (thousands); F (2014) = 0.47; SSB(2014)= 1342 t, Catch (2013)= 297 t.

Ffactor	Fbar	Catch 2013	Catch 2014	Catch 2015	Catch 2016	SSB 2015	SSB 2016	Change SSB 2015-2016(%)	Change Catch 2013-2015(%)
0	0	297	472	0	0	1423	2037	43	-100
0.10	0.04	297	472	66	83	1423	1954	37	-78
0.20	0.09	297	472	129	154	1423	1876	32	-57
0.30	0.13	297	472	187	216	1423	1803	27	-37
0.40	0.18	297	472	242	268	1423	1734	22	-18
0.50	0.22	297	472	294	313	1423	1669	17	-1
0.60	0.27	297	472	343	352	1423	1609	13	15
0.70	0.31	297	472	390	385	1423	1552	9	31
0.80	0.36	297	472	433	412	1423	1498	5	46
0.90	0.40	297	472	474	435	1423	1448	2	59
1.00	0.45	297	472	513	455	1423	1400	-2	73
1.10	0.49	297	472	550	471	1423	1355	-5	85
1.20	0.54	297	472	585	484	1423	1313	-8	97
1.30	0.58	297	472	618	495	1423	1273	-11	108

1.40	0.63	297	472	649	504	1423	1235	-13	118
1.50	0.67	297	472	678	511	1423	1200	-16	128
1.60	0.72	297	472	706	516	1423	1166	-18	137
1.70	0.76	297	472	733	520	1423	1135	-20	146
1.80	0.80	297	472	758	522	1423	1105	-22	155
1.90	0.85	297	472	782	524	1423	1076	-24	163
2.00	0.89	297	472	805	525	1423	1049	-26	171
F_{MSY}	0.14	297	472	195	223	1423	1794	26	-35

5.5.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-09.

5.5.4 Medium term implications

5.5.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.6 Short and medium term predictions for HAKE in GSA 9

5.6.1 Short term prediction 2014-2015

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 14-09.

5.6.1.1 Input parameters

The following data have been used to derive the input data for the short term projection of hake in the GSA 9.

Maturity

PERIOD	Age	0	1	2	3	4	5+
2005-2013	Prop. Matures	0	0.25	0.90	1	1	1

Natural mortality

PERIOD	Age	0	1	2	3	4	5+
2005-2013	M	1.30	0.60	0.46	0.41	0.30	0.2

F

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	1.13	0.58	0.47	0.71	1.37	0.39	1.19	0.34	0.37
1	1.57	1.72	2.17	1.83	1.87	1.65	2.28	1.88	1.95
2	1.06	1.76	1.43	1.17	0.99	1.27	1.51	1.68	1.58
3	1.32	1.74	1.82	1.46	1.43	1.44	1.89	1.78	1.76
4+	1.32	1.74	1.82	1.46	1.43	1.44	1.89	1.78	1.76

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2) set equal to the F of the last year (2013).

Weight-at-age in the catch and in the stock (kg)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.006	0.006	0.006	0.005	0.007	0.006	0.006	0.006	0.006
1	0.103	0.136	0.128	0.122	0.103	0.119	0.119	0.119	0.119
2	0.432	0.612	0.603	0.596	0.454	0.539	0.539	0.539	0.539
3	1.34	1.369	1.359	1.349	1.36	1.356	1.356	1.356	1.356
4	2.323	2.302	2.279	2.29	2.447	2.328	2.328	2.328	2.328
5+	3.202	3.312	3.284	3.288	3.202	3.257	3.257	3.257	3.257

Number at age in the catch (thousands)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	45189.5	19322.6	13176.1	25961.5	57213.0	9317.3	36656.8	9817.0	9791.6
1	8874.0	6266.6	8363.4	6908.5	7805.2	5477.8	6902.4	4800.2	8013.8
2	574.1	1117.1	591.2	411.3	460.9	574.5	581.6	357.5	389.1
3	47.2	164.4	125.9	91.5	91.1	136.1	124.7	88.5	43.8
4	12.5	56.8	35.4	25.8	40.5	65.7	47.8	34.5	17.3
5+	7.6	8.0	19.0	14.1	16.0	37.4	23.1	15.4	9.3

5.6.1.2 Recruitment

The recruitment used for the short term projection was estimated as the geometric mean from 2011-2013 (64.5 million).

5.6.2 Outlook until 2016

Table 5.6.2.1. Hake in GSA 9. Short term forecast in different F scenarios computed for. Basis: F (2014) = F (2013) = 1.3; R (2014) = GM (2011–2013) = 64.5 (million); SSB (2015) = 928 t; Catch (2014) = 1574 t.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	SSB 2016	Change SSB 2015-2016 (%)	Change Catch 2013-2015 (%)
zero catch	0	0.00	0.0	0.0	4150.7	347.2	-100.0
High long-term yield (F_{MSY})	0.17	0.22	448.0	1029.6	3166.0	241.1	-71.7
Status quo	1	1.30	1565.3	1560.8	924.8	-0.4	-1.3
Different scenarios	0.1	0.13	278.3	693.0	3535.4	280.9	-82.5
	0.2	0.26	517.1	1147.7	3017.1	225.0	-67.4
	0.3	0.39	722.5	1433.6	2580.1	178.0	-54.4
	0.4	0.52	899.6	1601.1	2211.2	138.2	-43.3
	0.5	0.65	1052.6	1686.2	1899.5	104.6	-33.6
	0.6	0.78	1185.2	1714.7	1635.8	76.2	-25.3
	0.7	0.91	1300.4	1705.1	1412.4	52.2	-18.0
	0.8	1.04	1400.7	1670.6	1222.9	31.7	-11.7
	0.9	1.17	1488.5	1620.3	1061.8	14.4	-6.1
	1.1	1.43	1633.0	1496.5	807.9	-13.0	3.0
	1.2	1.56	1692.7	1430.6	708.0	-23.7	6.7
	1.3	1.69	1745.5	1365.0	622.6	-32.9	10.1
	1.4	1.82	1792.5	1301.1	549.2	-40.8	13.0
	1.5	1.95	1834.4	1239.7	486.2	-47.6	15.7
	1.6	2.08	1872.0	1181.3	431.8	-53.5	18.1
	1.7	2.21	1905.7	1126.2	384.8	-58.5	20.2
	1.8	2.34	1936.1	1074.4	344.1	-62.9	22.1
	1.9	2.47	1963.6	1025.8	308.7	-66.7	23.8
	2	2.60	1988.6	980.5	277.9	-70.1	25.4

5.6.3 Short term implications

A short term projection (Table 5.6.2.1), assuming an F_{stq} of 1.3 in 2014 and a recruitment of 64.5 (million) individuals, shows that:

Fishing at the F_{stq} generates a decrease of the catch of 1.3 % from 2013 to 2015 and a decrease of the spawning stock biomass of 0.4% from 2015 to 2016.
Fishing at F_{MSY} (0.22) generates a decrease of the catch of about 72 % from 2013 to 2015 and an increase of the spawning stock biomass of 241 % in the same period.
Catches of hake in 2015 consistent with F_{MSY} would not exceed 448 tonnes.

5.6.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-09.

5.6.4 Medium term implications

5.6.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.7 Short and medium term predictions for RED MULLET in GSA 9

5.7.1 Short term prediction 2014-2016

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 14-09.

5.7.1.1 Input parameters

The input parameters used derive from the stock assessment performed with XSA. Different scenarios, zero catch, harvest at the F-based reference point F_{MSY}, Fstatus quo and a series of multipliers of F_{stq} were simulated. F_{stq}=0.70 was estimated as the geometric mean of the last three years of F values.

5.7.1.2 Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean (162960 thousands of individuals)

5.7.2 Outlook until 2015

Table 5.7.2.1. Red mullet in GSA 9. Short term forecast in different F scenarios.
Basis: F(2014) = mean(F_{0-1} 2011-2013)= 0.7; R(2014) = geometric mean of the recruitment of the last 3 years; R = 162960 (thousands); SSB(2014) = 1962t, Catch (2013)= 810 t.

	Ffactor	Fbar	Catch_2013	Catch_2014	Catch_2015	Catch_2016	SSB_2015	SSB_2016	Change_SSB_ 2015-2016(%)	Change_Catch 2013-2015(%)
	0	0.0	736	847	0	0	2131	3248	52.4	-100.0
	0.1	0.1	736	847	107	153	2131	3101	45.5	-85.5
	0.2	0.2	736	847	207	284	2131	2963	39.0	-71.8
	0.3	0.2	736	847	302	396	2131	2833	32.9	-59.0
	0.4	0.3	736	847	391	491	2131	2711	27.2	-46.8
	0.5	0.4	736	847	475	572	2131	2596	21.8	-35.4
	0.6	0.5	736	847	555	641	2131	2488	16.7	-24.6
	0.7	0.5	736	847	630	698	2131	2386	11.9	-14.4
	0.8	0.6	736	847	700	747	2131	2290	7.4	-4.8
	0.9	0.7	736	847	767	787	2131	2199	3.2	4.3
CURRENT	1.0	0.8	736	847	831	820	2131	2113	-0.8	12.9
	1.1	0.8	736	847	890	847	2131	2032	-4.6	21.1
	1.2	0.9	736	847	947	869	2131	1956	-8.2	28.8
	1.3	1.0	736	847	1001	886	2131	1884	-11.6	36.1
	1.4	1.1	736	847	1052	900	2131	1815	-14.8	43.0
	1.5	1.1	736	847	1100	909	2131	1750	-17.9	49.5
	1.6	1.2	736	847	1145	917	2131	1689	-20.8	55.7
	1.7	1.3	736	847	1189	921	2131	1631	-23.5	61.6
	1.8	1.4	736	847	1230	923	2131	1575	-26.1	67.2
	1.9	1.4	736	847	1269	924	2131	1523	-28.5	72.5
	2.0	1.5	736	847	1306	923	2131	1473	-30.9	77.6
F=0.1	0.79	0.6	736	847	695	743	2131	2297	7.8	-5.5

5.7.3 Short term implications

A short term projection (Table 5.7.2.1), assuming an F_{stq} of 0.70 in 2013 and a recruitment of 162960 thousands individuals show that:

Fishing at the F_{stq} (0.7) produces an increase of the catch of about 12.9 % from 2013 to 2015 along with a decrease of the spawning stock biomass of about 0.8 % from 2015 to 2016. Fishing at F_{MSY} (0.60) generates a decrease of the catch of about 5.5 % from 2013 to 2015 and an increase of the spawning stock biomass of about 7.8 % from 2015 to 2016. Catches of red mullet in 2015 consistent with F_{MSY} would not exceed 695 tonnes.

5.7.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-09 for the years 2006–2013.

5.7.4 Medium term implications

5.7.4.1 Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

5.8 Short and medium term predictions for BLUE WHITING in GSA 9

5.8.1 Short term prediction 2014-2016

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 14-09.

5.8.1.1 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. Different scenarios, zero catch, harvest at reference point, F_{stq} and a series of multiplier of F_{stq} were performed. F_{stq}=0.48 has been estimated as the geometric mean of the last three years 2011-2013 of F values estimated with FLR.

5.8.1.2 Recruitment

Recruitment (age 0) has been estimated from the population results from the geometric mean (7287 thousands individuals)

5.8.2 Outlook until 2015

Table 5.8.2.1. Blue whiting in GSA9. Short term forecast in different F scenarios.
Basis: F(2014) = mean(F_{1-3} 2011-2013)= 0.48; R(2014) = geometric mean of the recruitment of the last 3 years; R = 7287 (thousands); SSB(2014) = 281t, Catch (2013)= 102 t.

Rationale	**Ffactor**	**Fbar**	**Catch 2015**	**Catch 2016**	**SSB 2016**	**Change SSB 2015-2016(%)**	**Change Catch 2013-2015(%)**
Zero catch	0.00	0.00	0.00	0.00	456.22	44.16	-100.00
High long term yield F_{MSY}	0.69	0.33	93.74	103.78	348.69	10.18	-8.12
Status quo	1.00	0.48	126.67	126.44	311.97	-1.42	24.15
Different scenarios	0.10	0.05	15.88	21.68	437.75	38.32	-84.44
	0.20	0.10	30.92	40.68	420.33	32.82	-69.69
	0.30	0.14	45.18	57.31	403.91	27.63	-55.72
	0.40	0.19	58.71	71.82	388.42	22.74	-42.46
	0.50	0.24	71.54	84.47	373.80	18.11	-29.88
	0.60	0.29	83.72	95.47	359.99	13.75	-17.94
	0.70	0.34	95.29	105.01	346.95	9.63	-6.61
	0.80	0.38	106.28	113.25	334.63	5.74	4.17
	0.90	0.43	116.73	120.35	322.98	2.06	14.41
	1.10	0.53	136.12	131.64	301.55	-4.71	33.41
	1.20	0.57	145.12	136.05	291.68	-7.83	42.23
	1.30	0.62	153.70	139.77	282.34	-10.78	50.64
	1.40	0.67	161.87	142.89	273.49	-13.58	58.64
	1.50	0.72	169.65	145.47	265.10	-16.23	66.28
	1.60	0.77	177.08	147.59	257.14	-18.75	73.56

	1.70	0.81	184.17	149.29	249.60	-21.13	80.51
	1.80	0.86	190.94	150.64	242.43	-23.39	87.14
	1.90	0.91	197.41	151.68	235.63	-25.54	93.48
	2.00	0.96	203.59	152.44	229.16	-27.59	99.54

5.8.3 Short term implications

A short term projection (Table 5.8.2.1), assuming an F_{stq} of 0.48 in 2013 and a recruitment of 7287 thousands individuals show that:

Fishing at the F_{stq} (0.48) generates an increase of the catch of about 24% from 2013 to 2015 along with a decrease of the spawning stock biomass of about 1.4% from 2015 to 2016.
Fishing at F_{MSY} (0.33) generates a decrease of the catch of about 8% from 2013 to 2015 and an increase of the spawning stock biomass of about 10% from 2015 to 2016.
Catches of blue whiting in 2015 consistent with F_{MSY} would not exceed 94 tonnes.

5.8.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-09

5.8.4 Medium term implications

5.8.4.1 Method and justification

Medium term was not conducted because no meaningful stock-recruitment relationship was estimated.

5.9 Short and medium term predictions for NORWAY LOBSTER in GSA 9

5.9.1 Short term prediction 2014-2016

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 14-09.

5.9.1.1 Input parameters

The following data have been used to derive the input data for the short term projection of the Norway lobster stock in GSA 9:

Proportion of matures vector.

0+	1	2	3	4	5	6	7+
0.01	0.10	0.25	0.50	0.80	1.00	1.00	1.00

Natural mortality vector.

0+	1	2	3	4	5	6	7+
1.28	0.61	0.48	0.42	0.39	0.37	0.36	0.35

F vector.

Year	Age	0+	1	2	3	4	5	6	7+
2011		0.005	0.01	0.107	0.453	0.444	0.544	0.548	0.548
2012	F	0.000	0.013	0.103	0.451	0.459	0.654	0.67	0.67
2013		0.000	0.009	0.127	0.378	0.496	0.702	0.652	0.652
Mean 2011-2013		0.002	0.011	0.112	0.427	0.466	0.633	0.623	0.623

Weight at age in the stock.

Year	Age	0+	1	2	3	4	5	6	7+
2011	Mean	0.020	0.004	0.012	0.020	0.031	0.047	0.069	0.098
2012	weight	0.000	0.007	0.012	0.021	0.033	0.047	0.066	0.097
2013	in stock	0.000	0.004	0.011	0.020	0.033	0.048	0.069	0.106
Mean 2011-2013	(kg)	0.007	0.005	0.012	0.020	0.032	0.047	0.068	0.100

Weight at age in the catch.

Year	Age	0+	1	2	3	4	5	6	7+
2011	Mean	0.020	0.004	0.012	0.020	0.031	0.047	0.069	0.098
2012	weight	0.000	0.007	0.012	0.021	0.033	0.047	0.066	0.097
2013	in catch	0.000	0.004	0.011	0.020	0.033	0.048	0.069	0.106
Mean 2011-2013	(kg)	0.007	0.005	0.012	0.020	0.032	0.047	0.068	0.100

Number at age in the catch.

Year	Age	0+	1	2	3	4	5	6	7+
2011	Catch	142	173	1160	2571	1281	791	294	187
2012	at age	0	156	954	2384	1103	753	370	217
2013	(x1000)	0	161	822	1759	1092	653	271	156

Number at age in the stock.

year	Age	0+	1	2	3	4	5	6	7+
2011	Stock	59147	22948	14575	8712	4345	2266	834	519
2012	number at	90520	16370	12341	8106	3640	1887	908	520
2013	age (x1000)	71367	25168	8780	6886	3394	1557	678	381

5.9.1.2 Recruitment

Recruitment (age 0) has been estimated from the population results from the geometric mean of the last three years 2011-2013 (73 million individuals) estimated with FLR.

5.9.2 Outlook until 2015

Table 5.9.2.1. Norway lobster in GSA 9. Short term forecast in different F scenarios computed. Basis: F_{stq} = (2011-1013)=0.41 ; R (2013) = (2011–2013) = 73.3 (millions); SSB (2015) = 303 t; Catch (2013) = 148 tons, F_{bar}(2013)=0.41.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	SSB 2015	SSB 2016	Change SSB 2015-2016 (%)	Change Catch 2013-2015 (%)
Zero catch	0.00	0.00	0	0	303.3	425.5	40.26	-100.00
High long term yield ($F_{0.1}$)	0.52	0.21	74.5	83.2	303.3	347.5	14.54	-49.47
Status squo	1.00	0.41	128.6	121.1	303.3	292.2	-3.66	-12.80
Different scenarios	0.10	0.04	15.7	20.6	303.3	408.9	34.81	-89.39
	0.20	0.08	30.6	38.7	303.3	393.2	29.63	-79.26
	0.30	0.12	44.9	54.5	303.3	378.3	24.70	-69.58
	0.40	0.16	58.5	68.4	303.3	364.1	20.02	-60.34
	0.50	0.20	71.5	80.6	303.3	350.6	15.56	-51.50
	0.60	0.25	84.0	91.1	303.3	337.7	11.33	-43.06
	0.70	0.29	95.9	100.3	303.3	325.5	7.30	-34.98
	0.80	0.33	107.3	108.3	303.3	313.8	3.46	-27.26
	0.90	0.37	118.2	115.2	303.3	302.8	-0.19	-19.87
	1.10	0.45	138.6	126.1	303.3	282.2	-6.96	-6.03
	1.20	0.49	148.2	130.4	303.3	272.7	-10.11	0.46
	1.30	0.53	157.4	134.1	303.3	263.6	-13.11	6.67
	1.40	0.57	166.1	137.1	303.3	254.9	-15.96	12.62
	1.50	0.61	174.6	139.7	303.3	246.7	-18.68	18.32
	1.60	0.66	182.6	141.7	303.3	238.8	-21.28	23.79
	1.70	0.70	190.4	143.4	303.3	231.3	-23.75	29.04
	1.80	0.74	197.8	144.7	303.3	224.2	-26.10	34.07
	1.90	0.78	204.9	145.7	303.3	217.4	-28.35	38.90
	2.00	0.82	211.8	146.5	303.3	210.9	-30.49	43.54

5.9.3 Short term implications

A short term projection (Table 5.9.2.1), assuming an F_{stq} of 0.41 and a recruitment of about 73 million individuals, shows that:

Fishing at the F_{stq} from 2015 to 2016 generates a slightly decrease of about 4% in spawning stock biomass and from 2013 to 2015 a decrease of about 13 % in catch.
Fishing at F_{MSY} for the same time frame gives an increase of about 15% in the spawning stock biomass and a decrease of about 50% in catches.
Catches of norway lobster in 2015 consistent with FMSY would not exceed 75 tonnes.

5.9.3.1 Catches of blue whiting in 2015 consistent with FMSY would not exceed 94 tonnes.Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-19 for the years 2009–2013.

5.9.4 Medium term implications

5.9.4.1 Method and justification

Medium term was not conducted because no meaningful stock-recruitment relationship was estimated.

5.10 Short and medium term predictions for ANCHOVY in GSA 17-18

5.10.1 Short term prediction 2014-2016

5.10.1.1 Method and justification

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with SAM method conducted in the framework of the EWG 14-09.

5.10.1.2 Input parameters

The input parameters were the same used for the SAM stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

5.10.1.3 Recruitment

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (64167 millions individuals).

5.10.1.4 Results

A short term projection (Table 5.11.1), assuming an F_{stq} of 1.16 in 2013 and a recruitment of 64167 millions individuals, shows that:

Fishing at the F_{stq} (1.156) from 2013 to 2015 generates an increase of the catch of 8.33 % and an increase of the spawning stock biomass of 0.32% from 2015 to 2016.
Fishing at F_{MSY} (0.50) from 2013 to 2015 generates a decrease of the catch of 43.2% and a spawning stock biomass increase of 2.7 % from 2015 to 2016.
Catches of anchovy in 2015 consistent with F_{MSY} (0.50) would not exceed 18470 tonnes.

5.10.2 Outlook for 2015-2016

Table 5.10.2.1. Anchovy in GSA 17-18. Short term forecast in different F scenarios.

	Ffactor	Fbar	Catch_2013	Catch_2014	Catch_2015	Catch_2016	SSB_2015	SSB_2016	Change_SSB_2015-2016(%)	Change_Catch_2013-2015(%)
Zero Catch	0.00	0.00	32517	35432	0	0	324669	345656	6.464	-100.00
High long-term yield (F_{MSY})	0.43	0.50	32517	35432	18470	23130	319266	327880	2.698	-43.20
F status quo	1.00	1.16	32517	35432	35227	36302	312902	313897	0.318	8.33
Different scenarios	0.10	0.12	32517	35432	4922	7476	323373	340663	5.347	-84.86
	0.20	0.23	32517	35432	9406	13368	322107	336278	4.400	-71.08
	0.30	0.35	32517	35432	13513	18109	320868	332396	3.593	-58.44
	0.40	0.46	32517	35432	17296	22003	319656	328933	2.902	-46.81
	0.50	0.58	32517	35432	20800	25266	318470	325819	2.308	-36.03
	0.60	0.69	32517	35432	24061	28054	317309	323001	1.794	-26.01

	0.70	0.81	32517	35432	27109	30480	316173	320434	1.348	-16.63
	0.80	0.92	32517	35432	29972	32625	315060	318079	0.958	-7.83
	0.90	1.04	32517	35432	32672	34551	313970	315909	0.618	0.48
	1.10	1.27	32517	35432	37653	37912	311855	312023	0.054	15.79
	1.20	1.39	32517	35432	39965	39407	310829	310270	-0.180	22.90
	1.30	1.50	32517	35432	42174	40808	309823	308624	-0.387	29.70
	1.40	1.62	32517	35432	44289	42129	308837	307073	-0.571	36.20
	1.50	1.73	32517	35432	46321	43383	307869	305606	-0.735	42.45
	1.60	1.85	32517	35432	48275	44578	306919	304214	-0.881	48.46
	1.70	1.96	32517	35432	50160	45724	305987	302890	-1.012	54.26
	1.80	2.08	32517	35432	51980	46825	305073	301628	-1.129	59.85
	1.90	2.20	32517	35432	53740	47887	304174	300421	-1.234	65.27
	2.00	2.31	32517	35432	55445	48915	303292	299266	-1.328	70.51

5.10.3 Short term implications

5.10.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the SAM stock assessments performed during EWG 14-09.

5.10.4 Medium term implications

5.10.4.1 Method and justification

Reference points (fishing mortality and biomass) were estimated for anchovy in GSA 17-18, whose stock assessment is included in section 3.2.11.

Estimation of reference points was done based on the methodology described in Simmonds et al., (2011) which originated as a working document to the 2010 WKFRAME meeting (Anon., 2010): the same procedure was applied to the same stock during the EWG 12-19 (STECF, 2013). The framework uses computer intensive methods to estimate MSY (Maximum Sustainable Yield) reference points and calculates for a given value of B_{lim} corresponding Flim reference points with a probabilistic interpretation. The results for the species are summarized in the following table (Table 5.10.4.1.1).

Table 5.10.4.1.1. Anchovy in GSA 17-18. Estimated reference points. F_{lim5}, and F_{lim10} are the F values that give a 5% and 10% probability of SSB falling below B_{lim}. F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. B_{lim} was defined as 30% of maximum observed SSB.

Ref. points	Anchovy
B_{lim}	42546
B_{pa}	59564
F_{lim5}	0.54
F_{lim10}	0.59
F_{MSY}	0.62
$F_{maxCatch}$	0.50
SSB at F_{MSY}	140295
SSB at $F_{maxCatch}$	169175

The EWG 14-09 adopted as F_{MSY} the F that maximises the average catches ($F_{maxCatch}$).

The fits of the stock recruitment model are shown in figure 5.10.4.1.1 and the results of the simulations are given in figure 5.10.4.1.2. A hockey-stick model was applied to the anchovy stock (Breakpoint = 160,000 tonnes). The SSB considered in the model included 30% of age 0, and from age 1 to 4+. B_{lim} was chosen as the minimum spawning stock biomass throughout the time series.

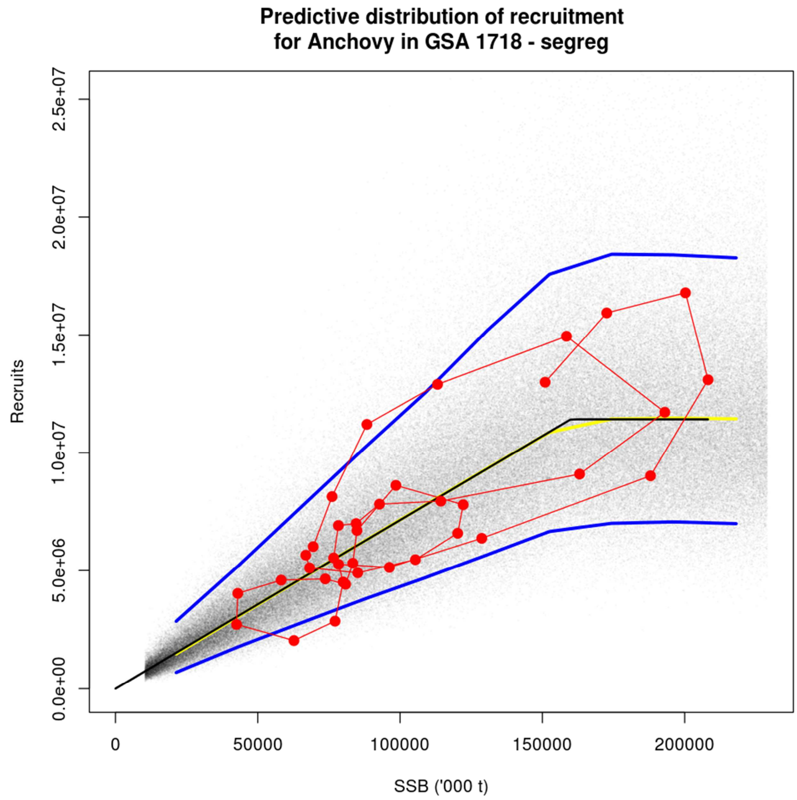

Figure 5.10.4.1.1. Anchovy in GSA 17-18. Hockey-stick stock-recruitment model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles.

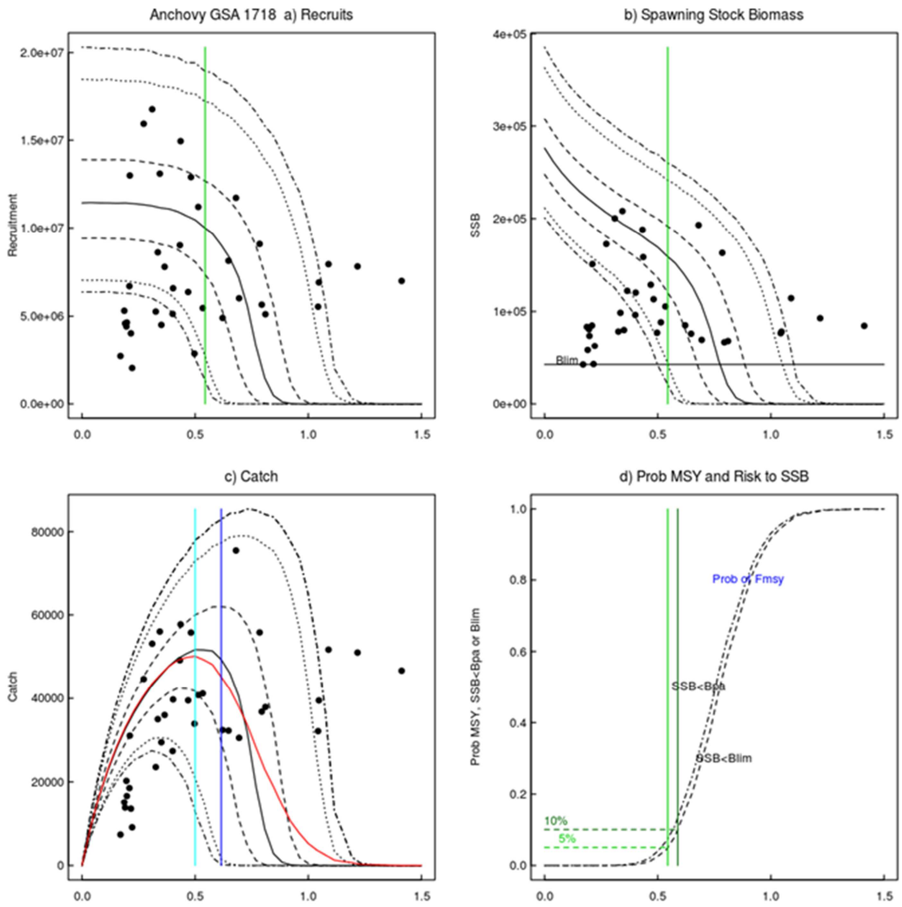

Figure 5.10.4.1.2. Anchovy in GSA 17-18. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar}, the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5}. Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5}. Panel c) shows catch against F_{bar}, here a red line shows average equilibrium catch, which is maximised at $F_{max\ catch}$ indicated by a vertical light blue line. In the final panel (d), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

5.11 Short and medium term predictions for SARDINE in GSA 17-18

5.11.1 Short term prediction 2014-2016

5.11.1.1 Method and justification

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with SAM method conducted in the framework of the EWG 14-09.

5.11.1.2 Input parameters

The input parameters were the same used for the SAM stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

5.11.1.3 Recruitment

Recruitment (age 1) has been estimated from the population results as the geometric mean of the last 3 years (10072 millions individuals).

5.11.1.4 Results

A short-term projection (Table 5.12.1), assuming an F_{stq} of 0.69 in 2014 and a recruitment of 10072 millions individuals, shows that:

Fishing at the F_{stq} (0.695) from 2013 to 2015 generates a reduction of the catch of 6.28 % and a decrease of the spawning stock biomass of 0.95% from 2014 to 2015.
Fishing at F_{MSY} (0.23) from 2013 to 2015 generates a decrease of the catch of 61.6 % and a spawning stock biomass increase of 7.8 % from 2015 to 2016.
Catches of sardine in 2015 consistent with F_{MSY} would not exceed 24554 tonnes.

Table 5.11.1.4.1. Sardine in GSA 17-18. Short term forecast in different F scenarios.

	Ffactor	Fbar	Catch_2013	Catch_2014	Catch_2015	Catch_2016	SSB_2015	SSB_2016	Change_SSB_2015-2016(%)	Change_Catch_2013-2015(%)
Zero Catch	0.00	0.00	63978	63317	0	0	190869	222177	16.40	-100.00
High long-term yield (F_{MSY})	0.33	0.23	63978	63317	24554	29782	178232	192138	7.80	-61.62
F status quo	1.00	0.69	63978	63317	59961	57412	157578	156083	-0.95	-6.28
Different scenarios	0.10	0.07	63978	63317	8102	11070	186845	211759	13.33	-87.34
	0.20	0.14	63978	63317	15577	20141	183005	202599	10.71	-75.65
	0.30	0.21	63978	63317	22505	27694	179337	194475	8.44	-64.82
	0.40	0.28	63978	63317	28951	34057	175828	187219	6.48	-54.75
	0.50	0.35	63978	63317	34969	39470	172467	180700	4.77	-45.34
	0.60	0.42	63978	63317	40601	44114	169245	174815	3.29	-36.54
	0.70	0.49	63978	63317	45886	48130	166152	169476	2.00	-28.28
	0.80	0.56	63978	63317	50857	51629	163181	164613	0.88	-20.51
	0.90	0.63	63978	63317	55540	54699	160326	160166	-0.10	-13.19
	1.10	0.76	63978	63317	64143	59828	154934	152322	-1.69	0.26
	1.20	0.83	63978	63317	68104	61994	152386	148845	-2.32	6.45

	1.30	0.90	63978	63317	71862	63950	149930	145619	-2.88	12.32
	1.40	0.97	63978	63317	75433	65728	147562	142618	-3.35	17.91
	1.50	1.04	63978	63317	78832	67355	145276	139817	-3.76	23.22
	1.60	1.11	63978	63317	82072	68854	143069	137195	-4.11	28.28
	1.70	1.18	63978	63317	85165	70242	140938	134733	-4.40	33.12
	1.80	1.25	63978	63317	88121	71536	138878	132417	-4.65	37.74
	1.90	1.32	63978	63317	90950	72747	136886	130231	-4.86	42.16
	2.00	1.39	63978	63317	93662	73887	134959	128163	-5.04	46.40

5.11.2 Outlook until 2015

5.11.3 Short term implications

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the SAM stock assessments performed during EWG 14-09.

5.11.4 Medium term implications

5.11.4.1 Method and justification

Reference points (fishing mortality and biomass) were estimated for sardine in GSA 17-18, whose stock assessment is included in section 3.2.12.

Estimation of reference points was done based on the methodology described in Simmonds et al., (2011) which originated as a working document to the 2010 WKFRAME meeting (Anon., 2010): the same procedure was applied to the same stock during the EWG 12-19 (STECF, 2013). The framework uses computer intensive methods to estimate MSY (Maximum Sustainable Yield) reference points and calculates for a given value of Blim corresponding Flim reference points with a probabilistic interpretation. The results for the species are summarized in the following table (Table 5.11.4.1.1).

Table 5.11.4.1.1 Sardine GSA 17-18. Estimated reference points. F_{lim5}, and F_{lim10} are the F values that give a 5% and 10% probability of SSB falling below B_{lim}. F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. B_{lim} was defined as 30% of maximum observed SSB.

Ref. points	Sardine
B_{lim}	153507
B_{pa}	214909
F_{lim5}	0.20
F_{lim10}	0.23
F_{MSY}	0.27
$F_{maxCatch}$	0.23
SSB at F_{MSY}	356223
SSB at $F_{maxCatch}$	401961

The EWG 14-09 adopted as F_{MSY} the F that maximises the average catches ($F_{maxCatch}$).

The fits of the stock recruitment model are shown in figure 5.11.4.1.1 and the results of the simulations are given in figure 5.11.4.1.2. A hockey-stick model was applied to the sardine stock (Breakpoint = 400,000 tonnes). B_{lim} was derived as a fraction of B_{pa}, which in turn was estimated from the SSB highest point throughout the time series ($B_{lim} = B_{pa} / 1.4$; $B_{pa} = 0.4 * SSB_{max}$).

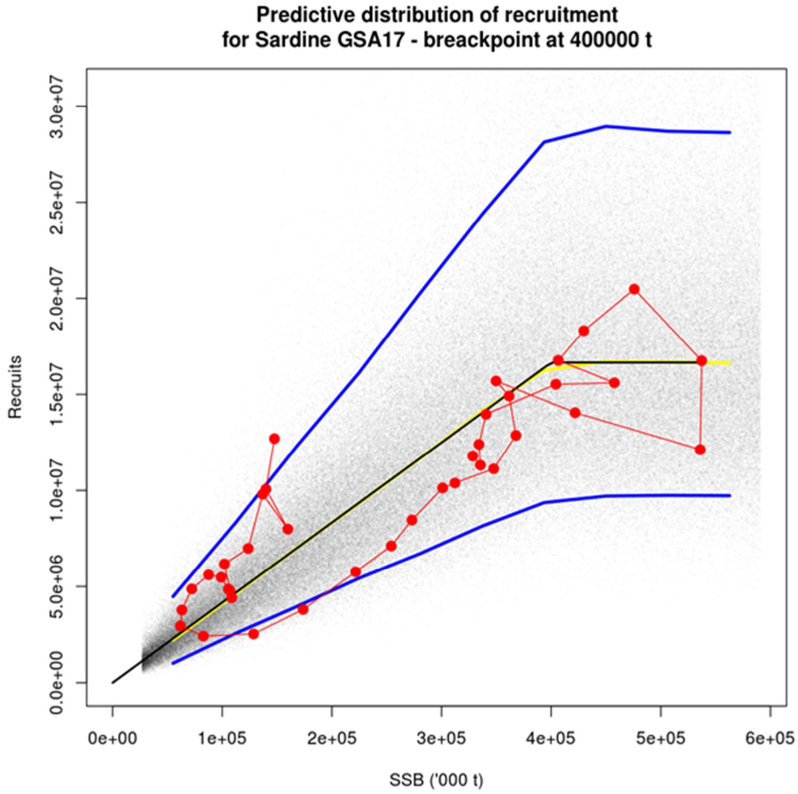

Figure 5.11.4.1.1 Sardine GSA 17-18. Hockey-stick stock-recruitment model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles.

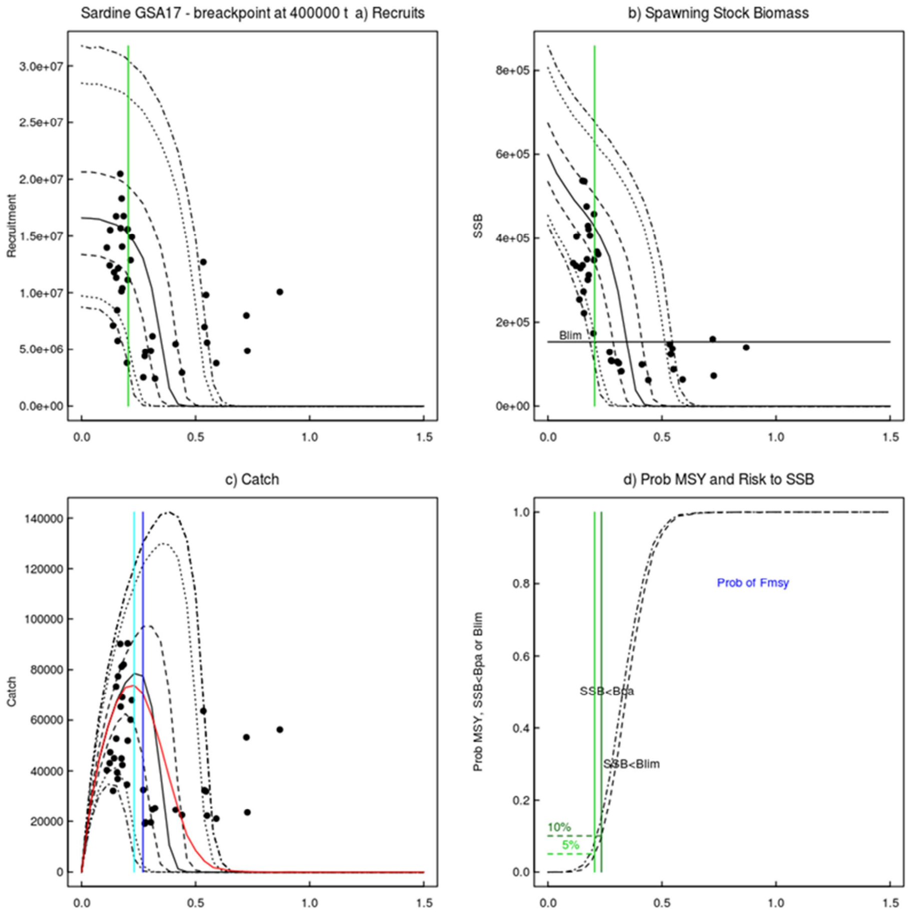

Figure 5.11.4.1.2. Sardine GSA 17-18. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against Fbar, the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of Flim5. Panel b) show the same for SSB against F with a solid horizontal line representing Blim highlighting the definition of Flim5. Panel c) shows catch against Fbar, here a red line shows average equilibrium catch, which is maximised at Fmax catch indicated by a vertical light blue line. In the final panel (d), Flim5 (green) and Flim10 (dark green) are shown as vertical lines.

6 TOR D) DATA QUALITY AND COMPLETENESS

Review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2014. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based the data format of the official DCF data calls for the Mediterranean issued on April 2014.

The data call issued on April 2014 for the Mediterranean and Black Sea had a deadline on the 9th of June 2014. Data was uploaded by each country according to the following table:

Table 6.1. Timeline of data upload from Mediterranean Member States, data call **deadline of the 9th of June 2014**.

COUNTRY	First Upload	Last Upload
ITA	02 June 2014	11 July 2014
ESP	27 June 2014	03 July 2014
FRA	06 June 2014	01 July 2014
SVN	04 June 2014	02 July 2014
MLT	06 June 2014	06 June 2014
CYP	02 June 2014	11 July 2014
GRC	08 June 2014	07 July 2014
HRV	05 June 2014	09 June 2014

The timeline of upload has been in many cases well after the data call deadline and up to 1 working days before the STECF EWG 14-09. The data call does not put explicit restrictions on the numbers of files to be uploaded for each requested table, however large amount of separate files with no standard naming convention can create problems to both Member States (MS) and JRC. Normally each country should provide 4 fisheries tables, 6 MEDITS tables and 3 acoustic surveys tables (the latter are not necessary for countries which does not conduct an acoustic survey). In the case of the large size of TC MEDITS file, splitting of the data in more files is necessary, thus 15-20 files are considered normal in a data call. However reaching almost 150+ files implies unnecessarily splitting of the individual tables by year and GSA. This is an unjustified practice that can cause serious problems. For instance, several files named with the same name contained different data, or in another case files with different names contained the same or partially overlapping data. Finally in many instances the fields of the files where not conform to the data call and integers instead of text or vice versa appeared in the uploaded data.
All of the above has required an extra amount of work and time for the JRC data collection team to check for duplicated records and errors. The JRC data collection team has been able to deliver all data (fisheries and MEDITS survey) the last working day before the beginning of EWG 14-09. Raw uploaded files were also available during the meeting. The progress of submission status between the deadline (9 Jun 2014) and the meeting starting date (14 Jul 2014) is portrayed in Tables 6.2 and 6.3 below.

Table 6.2. Data submission status by Country-GSA on the **deadline (09 Jun 2014)**.

CTRY	GSA	ABUND_BIO	ABUNDANCE	BIOMASS	CATCH	DISCARDS	EFFORT	LANDINGS	TA	TB	TC	TD	TE	TT	COMMENTS
CYP	SA 13						*								no catch/land/disc data forGSA 13
	SA 14						*								no catch/land/disc data forGSA 14
	SA 15						*								no catch/land/disc data forGSA 15
	SA 19						*								no catch/land/disc data forGSA 19
	SA 21						*								no catch/land/disc data forGSA 21
	SA 24						*								no catch/land/disc data forGSA 24
	SA 25				*	*	*	*	*	*	*		*		
	SA 26						*								no catch/land/disc data forGSA 26
ESP	SA 1														No data submitted
	SA 2														
	SA 5														
	SA 6														
	SA 7														
FRA	SA 7	*	*	*	*	*	*	*		*	*		*		Range errors in TA
	SA 8									*	*		*		Range errors in TA - Data for SA 8?
GRC	SA 20	*	*	*	*	*		*	*	*	*	*			no effort data for GSA20
	SA 22	*	*	*	*	*		*	*	*	*	*			no effort data for GSA22
	SA 23				*	*		*							no effort data for GSA23
HRV	SA 17	*	*	*	*	*	*	*	*	*	*		*		
ITA	SA 9				*	*	*	*	*	*	*		*		
	SA 10				*	*	*	*	*	*	*		*		
	SA 11				*	*	*	*	*	*	*		*		
	SA 16	*	*	*	*	*	*	*	*	*	*		*		
	SA 17	*	*	*	*	*	*	*	*	*	*		*		
	SA 18	*	*	*	*	*	*	*	*	*	*		*		
	A 1				*	*	*	*	*	*	*		*		
MLT	SA 15	*	*	*	*	*	*	*	*	*	*	*			
SVN	SA 17		*	*	*	*	*	*	*	*	*		*		no Abund_Bio data

Table 6.3. Data submission status by Country-GSA **on the starting date of the EWG 14-09 (14 Jul 2014)**.

CTRY	GSA	ABUND_BIO	ABUNDANCE	BIOMASS	CATCH	DISCARDS	EFFORT	LANDINGS	TA	TB	TC	TD	TE	TT	COMMENTS
CYP	SA 13						*								no catch/land/disc data forGSA 13
	SA 14						*								no catch/land/disc data forGSA 14
	SA 15						*								no catch/land/disc data forGSA 15
	SA 19						*								no catch/land/disc data forGSA 19
	SA 21						*								no catch/land/disc data forGSA 21
	SA 24						*								no catch/land/disc data forGSA 24
	SA 25				*	*	*	*	*	*	*		*		
	SA 26						*								no catch/land/disc data forGSA 26
ESP	SA 1	*	*	*	*	*	*	*	*	*	*		*		minor errors in MEDITS_TA
	SA 2				*	*	*	*	*	*	*		*		minor errors in MEDITS_TA
	SA 5				*	*	*	*	*	*	*		*		minor errors in MEDITS_TA
	SA 6	*	*	*	*	*	*	*	*	*	*		*		minor errors in MEDITS_TA
	SA 7				*	*	*	*							
FRA	SA 7	*	*	*	*	*	*	*	*	*	*		*		effort data only for years 2012-2013; minor range errors in TA
	SA 8								*	*	*		*		no data for GSA 8
GRC	SA 20	*	*	*	*	*	*	*	*	*	*	*			no data for 2009-2012 and most of 2013 Discards only for 2013
	SA 22	*	*	*	*	*	*	*	*	*	*	*	*		
	SA 23				*	*	*	*				*			
HRV	SA 17	*	*	*	*	*	*	*	*	*	*		*		
ITA	SA 10				*	*	*	*	*	*	*		*		
	SA 11				*	*	*	*	*	*	*		*		
	SA 16	*	*	*	*	*	*	*	*	*	*		*		
	SA 17	*	*	*	*	*	*	*	*	*	*		*		
	SA 18	*	*	*	*	*	*	*	*	*	*		*		
	SA 19				*	*	*	*	*	*	*		*		
	SA 9				*	*	*	*	*	*	*		*		
MLT	SA 15	*	*	*	*		*		*	*	*	*			
SVN	SA 17		*	*	*	*	*	*	*	*	*		*		no Abund_Bio datafile - Abundance & Biomass files refer to MEDITS surveys,

6.1 Data Overview

A summary of the main data gaps is presented below while specific issues related to individual stocks are described in the dedicated chapter under each stock assessment section.

Italy (ITA)

- In general all Italian fisheries data lack the years before 2005.
- Discard data are as a rule fragmented and completely absent for years 2007-2008
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in many years-areas-gears are accompanied by very low or no catches at all
- MEDITS data appear complete

Spain (ESP)

- Spain has submitted all data after the official deadline of 9_{th} June 2014
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in many years-areas-gears are accompanied by very low or no catches at all
- MEDITS data appear complete

France (FRA)

- Complete absence of fisheries data for GSA 8
- No effort data before 2012
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in many years-areas-gears are accompanied by very low or no catches at all
- Very few species are declared in Discards data
- MEDITS data appear complete

Slovenia (SVN)

- Effort data initially uploaded for 2014 Data Call (and all previous Data Calls) were incorrect and extremely high. New correct version was uploaded after the deadline.
- Catches (Landings , Discards) during the last two years (2012-2013) show a dramatic decline (70-80%)
- Hydroacoustic survey data files consist of MEDITS demersal survey data
- MEDITS data appear complete

Malta (MLT)

- No discard data for 2013
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in some years-areas-gears are accompanied by very low or no catches at all
- MEDITS data appear complete

Cyprus (CYP)

- Effort is declared for many GSA's outside the Cypriot GSA 25. However, no catches are declared outside GSA 25

- Landings for some target species are given only in tons without any information by length class
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in some years-areas-gears are accompanied by very low or no catches at all
- MEDITS data appear complete

Greece (GRC)

- No data for 2009-2012; data only for last quarter in 2013
- Discard data include only 2013
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in some years-areas-gears are accompanied by very low or no catches at all
- MEDITS data appear complete

Croatia (HRV)

- DCF initiated in 2013; as a result data were available for 2013 only (Effort: 2012-2013)
- Effort data and Catch data (Landings, Discards) are inconsistent: large effort values in some years-areas-gears are accompanied by very low or no catches at all
- Officially submitted sardine landings data was not used during EWG 14-09; experts identified them as incorrect and used their own 'correct' data
- MEDITS data only for 2013 (the survey is conducted for many years)

6.2 Fisheries Data Quality

An exploration of the submitted datasets revealed some issues requiring further investigation.

Data concerning catches (catch at age, landings at age, discards at age, landings at length, discards at length) follow a general pattern for almost all geographical subareas (Fig. 6.2.1): after the modification of the data collection scheme from DCR (2002-2008) to DCF (2009-2013) the number of species reported increased dramatically. As a rule, fewer species have catch at age information compared to catch at length.

Also noticable is the drop in the number of discarded species reported in most of the Italian areas after 2011 (Fig 6.2.1. top right).

The large inconsistencies in the catch data can be more easily identified when checked against the corresponding effort data: large effort values in some years-areas-gears are accompanied by very low or no catches at all. A summarized description of the identified inconsistencies is portrayed in Table 6.2.1.

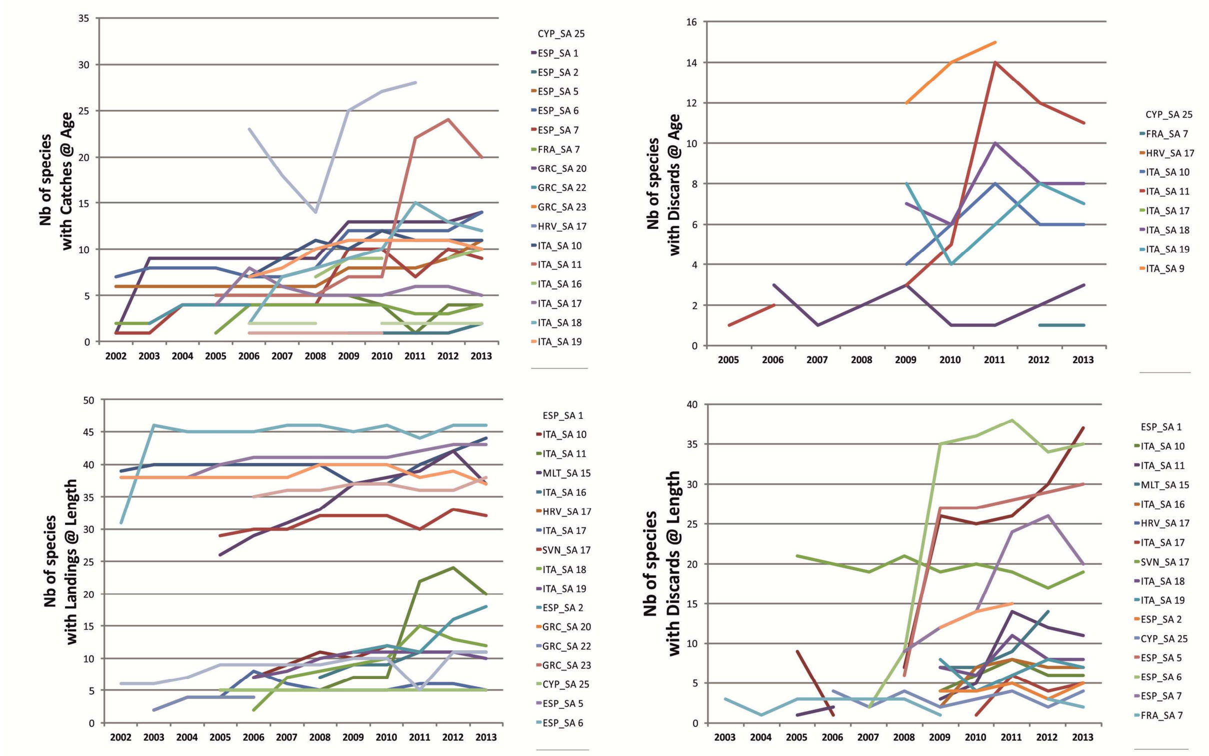

Fig. 6.2.1. Annual fluctuation of the number of species reported by geographical subarea in the 'Catch, 'Landings' and 'Discard' files.

Table 6.2.1. Inoconsitencies identified between the catch and effort data submissions.

Country/Area	Gear/Fishery	Issue
Croatia/SA17	LLS	Large effort in LLS | no demersal catches reported
Cyprus/SA25	PS	PS Effort declared only in 2008 | PS catch declared only in 2005
	GNS & LLD	No effort data for GNS & LLD | Catch data reported
Malta/SA15	LHM & LTL	Effort in 2006-2007 explodes (>10 x average) | catches reprted only in 2013
Spain/SA1,2,5,6,7	FPO	Effort more or less constant | landings have tripled in the same period
	SV	Effort data reported | no catches
	GTR-GNS	Effort more or less constant | landings have tripled in the same period
	LHM	Significant effort reported | Landings reported and only in 2013
	LLS	Huge effort reported | relatively low catches
Greece/SA20,22,23	FPO-GTR-GNS	No effort data before 2013 | Landings reported
France/SA7	all	No effort before 2012 | Landings reported
Italy/SA10-18-19	FPO-PS-DRB	Effort reported | no catch reported for DRB in areas 10-18; for PS in area 18; for FPO in area 19
Italy/SA17	GTR-DRB-FPO	Effort reported | no catch reported
Italy/SA11	GNS-GTR-LLS	Large effort reported | low or not at all catches reported
Italy/SA9	LLS	Dramatic drop in effort after 2008 | no catches rported
Slovenia/SA17	PTM	No effort after 2012 | no catcehs after 2012

The JRC Fisheries data overview R routine was employed for the main target species under assessment in EWG 14-09. Age based data was aggregated over ages, mesh sizes, fleet segment and metiers to identify the main temporal patterns. The landing numbers at age (Figure 6.2.2) show a lot of 'suspicious' trends: a continuous dramatic drop of the two assessed species in Cyprus; a huge increase in anchovy (GSA6) and Hake (GSA 7) for Spain; large fluctuations for all other areas.

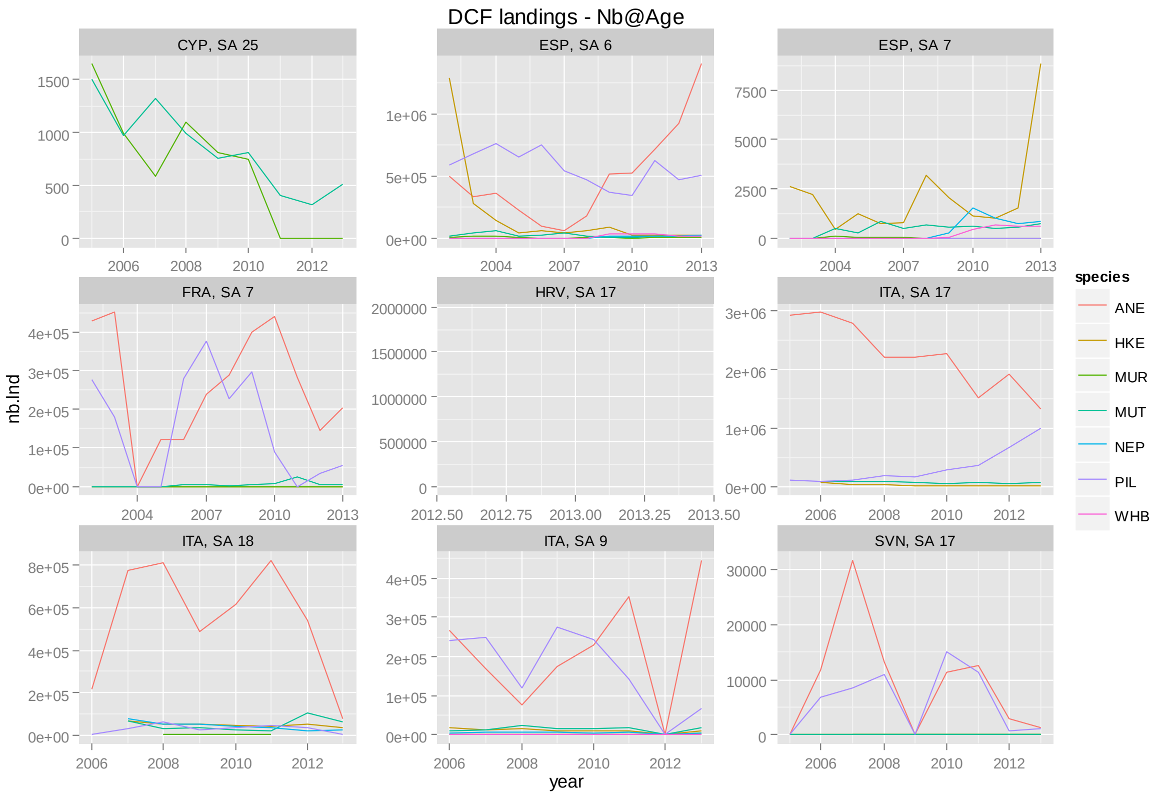

Figure 6.2.2 Landings numbers aggregated over ages and métiers from the 2014 data call for the species under assessment in EWG 14-09.

An exploration of the aggregated landings for the stocks for which there are detailed numbers at age and weight at age information shows for which combination of species and GSA data have been reported. The scaling of the weight on the y axis shows variations up to 3 orders of magnitude from one GSA to another and this might be related to inconsistent unit of weight (Fig. 6.2.3).
Similar plotting functions apply the same approach to DCF discards at length (Figure 6.2.4) to explore level and trends in discarding.

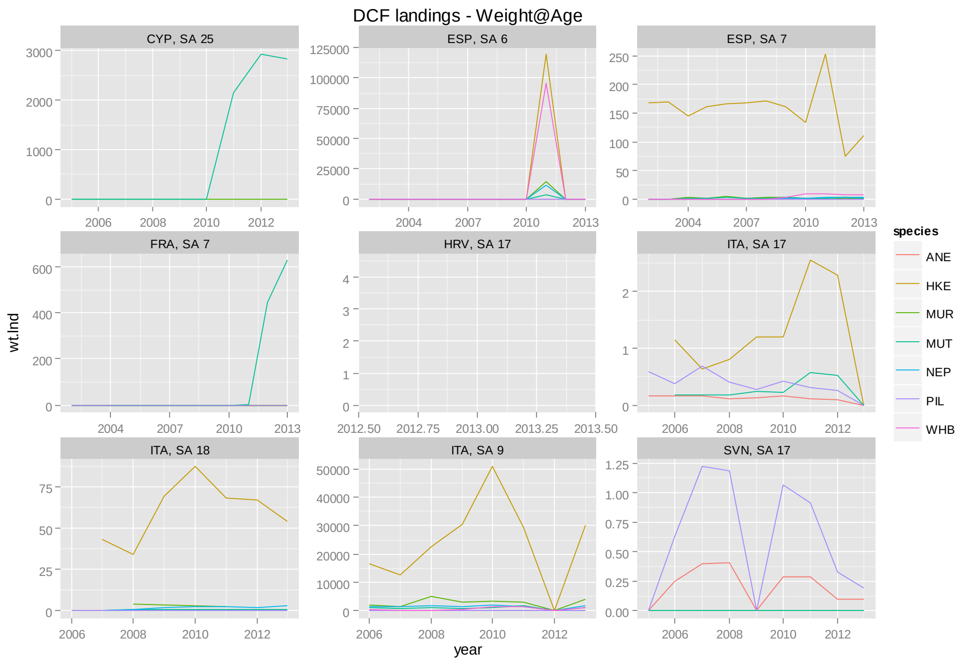

Figure 6.2.3 Landings in weight aggregated over ages and métiers from the 2014 data call for the species under assessment in EWG 14-09.

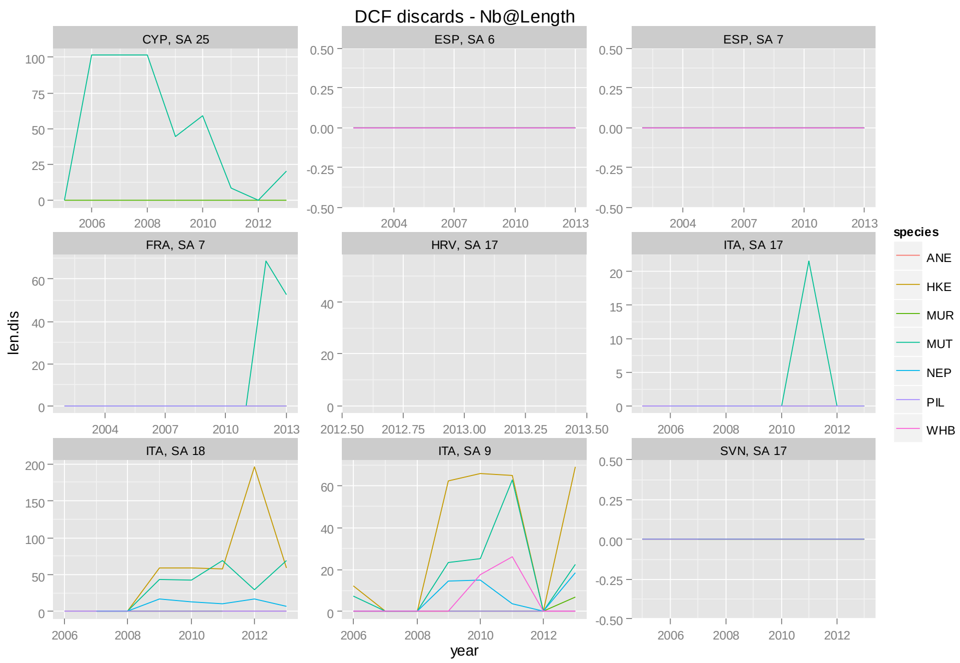

Figure 6.2.4 Discard numbers at length aggregated by species, year and GSA from the 2014 DCF data call for the species under assessment in EWG 14-09.

6.3 Surveys data quality

Annual trends of MEDITS hauls conducted through time can be seen on Fig. 6.3.1. Notable is the great fluctuation of hauls in some areas, taking into account that this is a standardized survey with strict protocols regarding annual sampling effort.

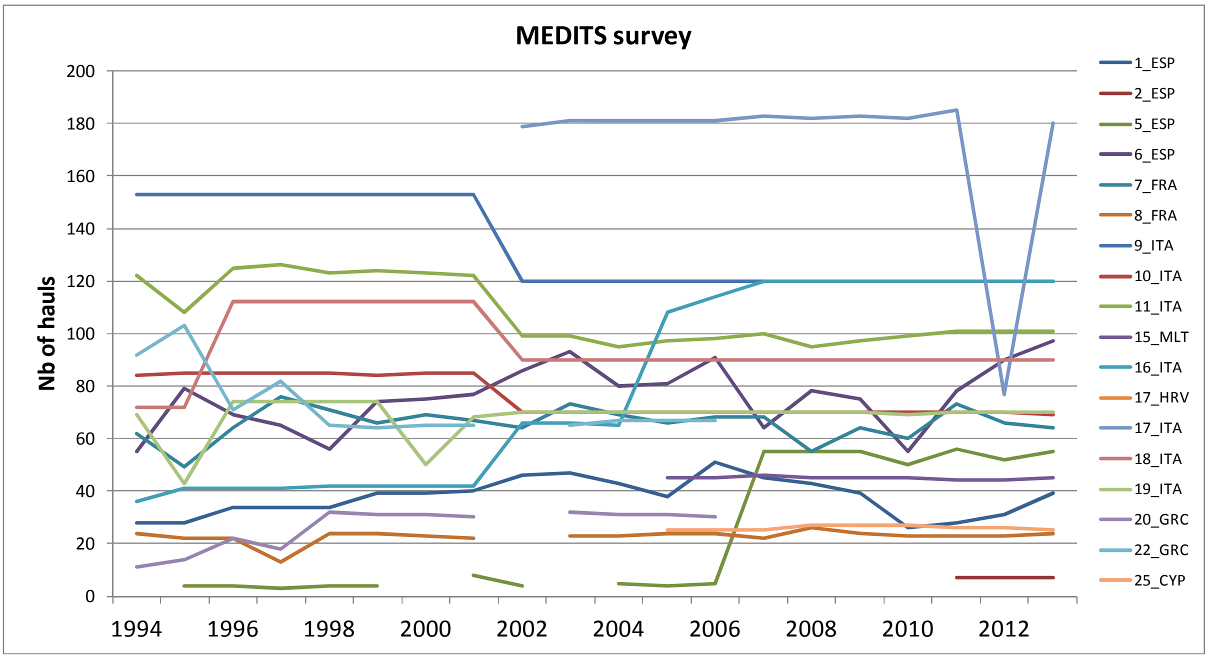

Figure 6.3.1. Annual trends of MEDITS hauls from the 2014 DCF data call.

The trends of number of species reported (Fig. 6.3.2) and number of species for which length was obtained ((Fig. 6.3.3) did not show large variability, however some areas require attention to be drawn on (e.g.: number of species reported - France and Italy; number of species for which length was obtained - Greece).

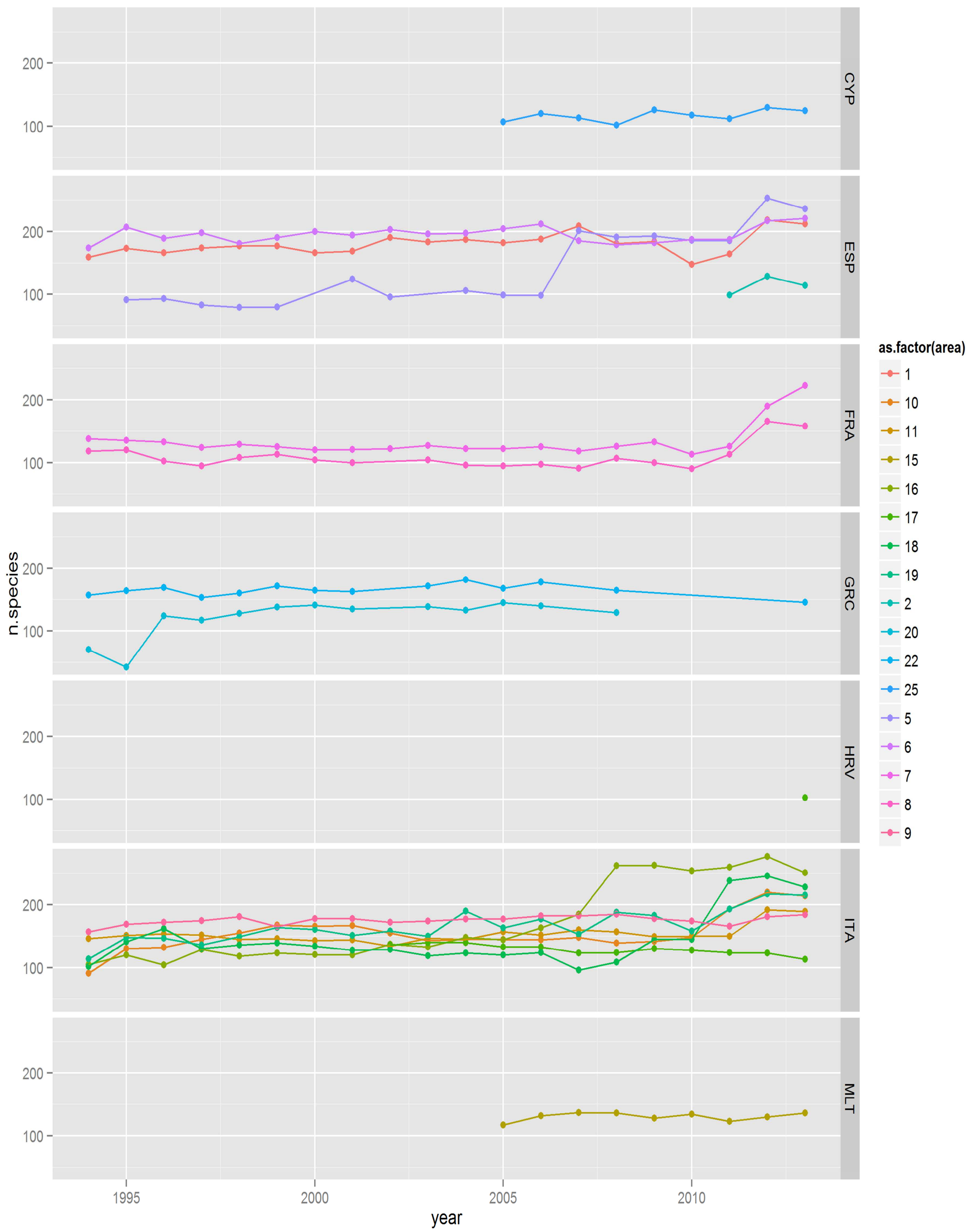

Figure 6.3.2. Annual trends of number of species reported in the MEDITS survey from the 2014 DCF data call

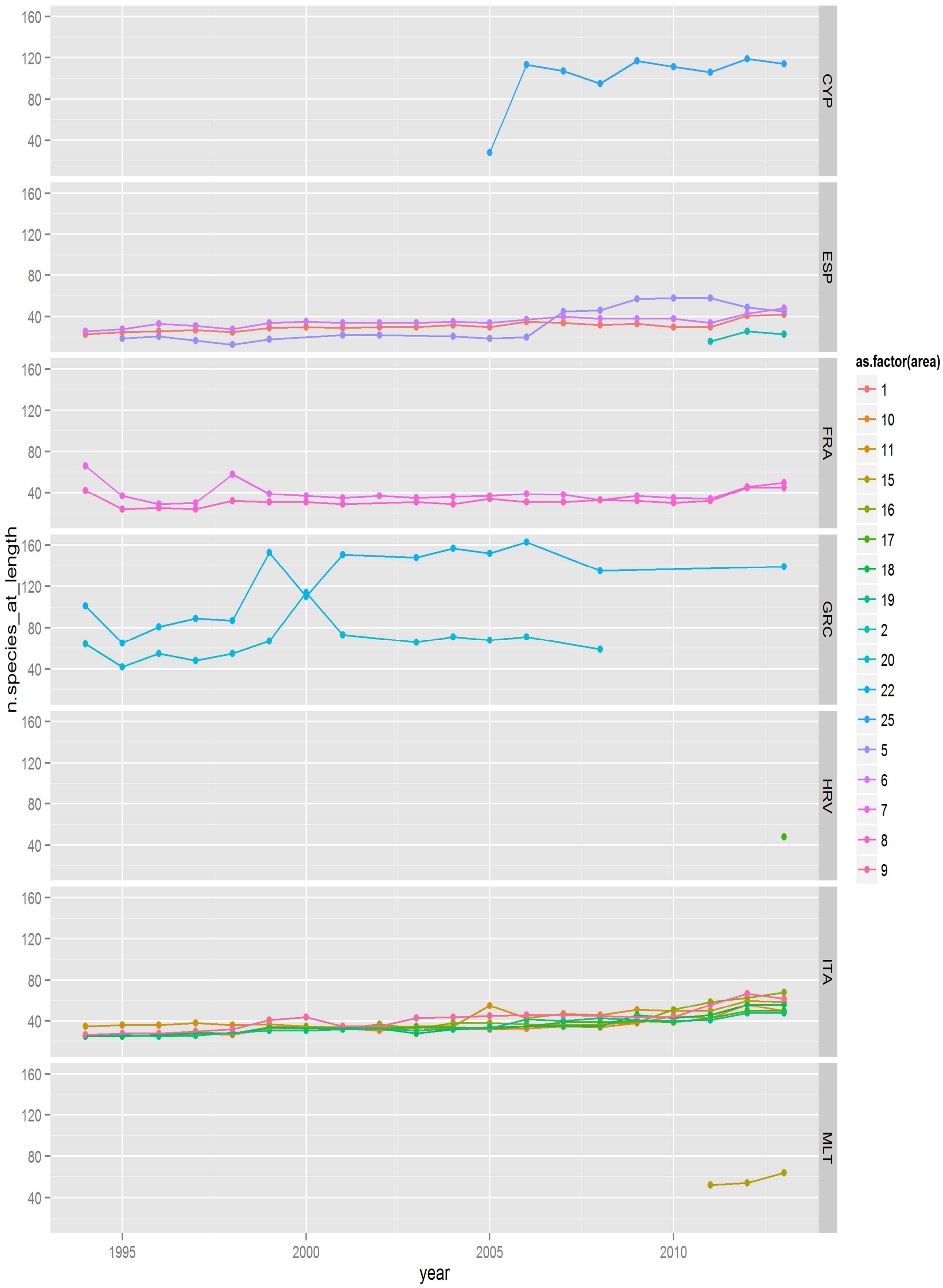

Figure 6.3.3. Annual trends of number of species for which length was obtained in the MEDITS survey from the 2014 DCF data call.

Based on the recently developed SQL routines in the MEDITS Postgres database of JRC to do cross table consistency tests, a number of quality check reports (number of erroneous records by year) were identifed for the data call of 2014 (Table 6.3.1).

Table 6.3.1. Inconistent records in the MEDITS file as submitted in the 2014 Data Call.

Issue	GSA Area	Nb of erroneous records
Shooting depth and haul depth not in same stratum	1	27
	2	2
	5	7
	6	18
	7	73
	8	47
	9	1
	10	23
	11	89
	15	19
	16	50
	17	51
	18	62
	19	4
	20	19
	22	87
	25	2
Distance covered consistency	1	58
	5	13
	6	83
	7	31
	8	14
	9	251
	10	36
	11	626
	15	15
	16	12
	17	90
	18	16
	19	4
	20	75
	22	319
	25	7
Zero vertical opening of trawl	1	5
Haul coordinates	1	6
	5	1
	6	14
	7	1
	9	16
	10	1
	11	12
	17	7
	18	3
	19	5
	22	10
	25	5
Number of sexed specimens not equal to numbres of lengthed specimens	1	1367
	5	2183
	6	2643
	7	22
	8	8
	10	1
	11	4
	15	8
	16	1860
	17	11
	18	3
	19	5
	20	146
	22	289
	25	4

TE table

The most significant problem arisen during the 2014 Data Call, regarding the MEDITS data submissions, was the insufficient structure design of TE table (biological parameters at individual level).
The problem was identified during the uploading process by member states. JRC database indicated errors related to duplicate rows of data, even when the case was not so.

This error occured whenever:

1) two or more specimen of the same species have been sampled during the same haul, have the same individual_weight, belong to the same length_class, and no age readings were collected.

or

2) two or more specimen of the same species have been sampled during the same haul, have the same individual_weight, belong to the same length_class, and have the same age estimate.

The last field in the MEDITS_TE table ("OTOLITH_CODE") when filled in with a value (as described in the MEDITS manual 2013 v.7) solves this issue, but this is applied to very few species. In general, when no age readings were available, this field is usually left blank and generated a "duplicate record" error during upload to JRC facilities.

This potential confounding stems from the lack of a column indicating the individual fish identity which would indicate whether two rows refer to the same fish or to two or more different ones. The issue was communicated to the MEDITS coordinator and needs to be addressed at MEDITS coordination level.

7 OTHERS

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9 CONTACT DETAILS OF STECF MEMBERS AND EWG-14-09 LIST OF PARTICIPANTS

1 - Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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10 List of Background Documents

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1409

List of background documents:

1. EWG-14-09 – Doc 1 - Declarations of invited and JRC experts (see also section 8 of this report – List of participants)

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Abstract
The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 14-09 was held from 14 – 18 July 2014 in Rome, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed F_{MSY} reference point. The report was reviewed by the STECF during its winter plenary held from 10 to 14 November 2014 in Brussels (Belgium).

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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